

CRANFIELD UNIVERSITY

Anandadeep Mandal

The Governing Dynamics of Stock-Bond Return Co-movements –
A Systematic Literature Review

School of Management
Master of Research

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Academic Year: 2011 -2012

Supervisor: Prof. Sunil S. Poshakwale
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of Research*

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Abstract

Understanding stock-bond return correlation is a key facet in asset mix, asset allocation and in an investor's portfolio optimisation strategy. For the last couple of decades, several studies have probed this cardinal relationship. While initial literature tries to understand the fundamental pattern of co-movements, later studies aim to model the economic state variables influencing such time-varying volatility behaviour of stock-bond returns. This study provides a systematic literature review in the field of stock and bond return correlation.

The review investigates the existing literature in three key dimensions. First, it examines the effect of macro-economic variables on SB return co-movements. Second, it illustrates the effect of financial integration on the asset correlation dynamics. Third, it reviews the existing models that are employed to estimate the dynamic relationship.

In addition to the systematic review, I conduct an empirical analysis of stock-bond return co-movements on U.S. capital market. Both the literature and the empirical investigation substantiate my claims on existing research gaps and respective scope for further research. Evidence shows that existing models impose strong restrictions on past stock-bond return variance dynamics and yield inconclusive results. I, therefore, propose an alternative method, i.e. copula function approach, to model stock and bond time-varying co-movements. Since the previous studies largely focus on developed economies, I suggest an empirically investigation of emerging economies as well. This will allow me to examine the effect of financial integration on the dynamic asset return correlation.

Apart from this academic contribution, the study provides an illustration of the economic implications which relate to portfolio optimization and minimal-risk hedge ratio.

Keywords: stock and bond, time-varying volatility, asset allocation, systematic literature review

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Special thanks to Dr. Stephanie Hussels and Ms. Heather Woodfield for assisting me in developing my systematic review protocol, which is a major component of this study. I also thank my additional panel members, especially Dr. Yacine Belghitar for their valuable insights. Additionally, I thank Ms. Wendy Habgood for her administrative support.

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1 Introduction

Following the financial crisis of 2007, academics as well as practitioners have been keen to understand the behaviour of financial assets in turbulent economic conditions. Asset allocation has attracted the attention of investors and researchers in the domain of portfolio return prediction and forecasting. The key requirements for understanding the approach to asset allocation are return, risk and the correlation of the asset classes. Ever since the seminal work of Markowitz (1952) asset correlation has been the prime focus of portfolio management. Bonds provide fixed income whereas stocks provide returns adjusted to the risk undertaken by an investor. Hence, choosing a combined portfolio of bonds and stocks allows the investor to optimise their return and diversify their risk. An investor adjusts the asset mix periodically in order to consider time-varying investment payoffs and risk factors associated with a portfolio. The lower the correlation the more suitable are the assets for diversification. Consequently, correlation of assets is decisive for risk management and control.

Against this backdrop, the aim of this systematic literature review, as a part of my doctoral study, is threefold. First, a sound literature review is central to my research as it will form the foundation for developing an informed conceptual model. This will enable me to build on and contribute to existing knowledge in the relevant fields. Second, a review of the existing theoretical and empirical knowledge is likely to reveal relevant constructs and third, it will help to lay the theoretical foundation which will subsequently guide the research questions for my successive empirical study. Based on the findings of a broad investigation of relevant literature domains in my scoping study, my overarching review question which I aim to answer in this systematic review is: *“To what extent, according to the literature, is time-varying stock-bond return correlated?”*

Drawing on this overarching question, I have three sub-questions that will help me in addressing the key issue. The sub-questions are:

1. Are the effects of macroeconomic variables on stock-bond returns in different economies common?
2. What are the effects of global integration on stock-bond return correlation?
3. How can the influence of macroeconomic variables on stock-bond return correlation be modelled?

My approach to this literature review has a number of distinctive features. First, I cast a clear approach to inclusion of papers for the review. The selection of the papers is based on well illustrated criteria, which assures that the study captures the key facets of the phenomenon under investigation. Second, I carry out an empirical analysis on the SB return co-movements illustrating the distinctive aspects of the time-varying phenomena. Third, the study provides a research question highlighting the necessity for further enquiry in the relevant field of SB return correlation.

The rest of the study unfolds as follows. Section 2 provides the theoretical background of my research. Section 3 details the literature review methodology. Section 4 provides the descriptive findings and Section 5 discusses the thematic findings of the extant literature. Section 6 provides an empirical analysis of SB return co-movements employing a model estimation procedure and discusses the avenues for further research. Finally, Section 7 concludes the study, highlighting the contribution of the literature review.

2 Theoretical Background

In this section I provide the conceptual background, setting the scope for the study. It is divided into three sub-sections, which are bond-return and yield volatility, SB return co-movements and stock price and return volatility which I discuss next.

2.1 Stock Price and Return Volatility

Monthly standard deviation estimates of US stock returns for the period 1860 to 2011 vary from negative 15 percent to positive 25 percent (Bekaert and Engstrom, 2010; Scruggs and Glabadanidis, 2003). Tests for estimation error for this large deviation strongly reject the hypothesis of constant variance. Significant changes in ex ante market volatility can have important implications for risk-averse investors, capital investments, consumption and other economic state variables. This gives rise to the question why stock returns vary over time, which I am going to discuss now.

Researchers in the past have studied aggregate variability of stock market returns. While Officer (1973) relates stock market volatility to macroeconomic factors, Christie (1982) attributes financial leverage as the primary principle for this time-varying phenomenon. Early attempts were made to associate market volatility with expected equity returns. Examples include Merton (1980), French et al. (1987) and Bollerslev et al. (1988). Mascaro and Meltzer (1983) and Lauterbach (1989) relate macroeconomic volatility to interest rate changes.

Over the years researchers have investigated the behaviour of stock market returns. The two most commonly investigated patterns relating to stock market volatility are i) the relationship between market returns and market volatility and ii) the variance in expected return pertaining to high frequency data (Berument and Dogan, 2012). Regarding the former, studies employing asset pricing models state that there is a positive relationship between market return and volatility (Lintner, 1965; Merton, 1973; Sharpe, 1963). Authors have used numerous estimation techniques with different specifications to state that investors require risk premiums to compensate for risky investments (Bekaert et al., 2007; Bollerslev et al., 1988; Campbell and Ammer, 1993; Scruggs and Glabadanidis, 2003). However, Cox and Ross (1976), Bekaert and Wu (2000) and Whitelaw (2000) propose a conflicting relationship for the above

phenomenon. Thus, the relationship between market return and volatility remains inconclusive.

In particular, extending on the work by Campbell (1988) and French et al. (1987), empirical studies reveal two puzzling results relating to intertemporal market return and volatility. First, as discussed, the studies provide negative conditional correlation between return and volatility. Second, authors reveal a significant dynamic relationship of this phenomenon (Brandt and Kang, 2004; Glosten et al., 1993; Whitelaw, 1994). In particular, using a multivariate generalized auto-regressive conditional heteroskedastic (MGARCH) model, Glosten et al. (1993) show that during the post World War-II period the estimated volatility coefficients are negative. For the same time period, using monthly data, Whitelaw (1994) reveal a negative long-run correlation between the fitted moments as a function of pre-determined financial variables. Moreover, when short-run correlation is measured over 17-month horizon, it varies from -0.8 to 0.8. This evidence is supported by Boudoukh et al. (1997), employing a non-parametric estimation of annual data.

These results are interesting as they refute the commonly held intuition of a positive relationship between market return and volatility. Two predominant questions arise. First, relating to the consistency of the results, do these findings pertain to both general equilibrium models and time-series properties of the exogenous variables? Second, what factors generate the counter-intuitive pattern of market return and volatility?

Concerning the volatility pattern of expected returns for high frequency data, the literature states that investors behave differently on different days of the week. While individual investors are more active during the early days of the week, institutional investors are less active on Mondays (Lakonishok and Maberly, 1990). Documenting the day-of-the-week effect, literature claims that Mondays have negative returns in contrast to Fridays, which see significantly positive returns (Agrawal and Tandon, 1994; Chang et al., 1993; French, 1980; Osborne, 1962). The key reasons are i) news released over the weekend are reflected on the first day of the week, ii) most informed trading occurs on the first day relative to the remaining days of the week and iii) preferences of individual traders differ from institutional traders.

Yet, in order to explain the variation in returns of a diversified portfolio, it is critical to understand the factors that affect not only equities but also bonds, which assure fixed income. Hence, I next discuss the factors that affect bond returns.

2.2 Bond Price and Yield Volatility

Researchers have used duration analysis to estimate the changes in the interest rates, which affect prices of fixed-income securities. The concept of duration was first demonstrated by Macaulay (1938). It provides a comprehensive understanding of a bond's time-dimension, rather than term to maturity. Much of the theoretical research in this field is based on the concept of duration. Studies have concentrated on identifying the relationship between bond price change and duration for a given change in yield. Samuelson (1945) uses duration to study the effect of change in interest rate on a portfolio of bonds. He considers the effect of increase in interest rates along a yield curve and concludes that there is a capital gain in liability position for an increase in the interest rates. Grove (1974) considers the case of shift in yield curves and reaches at the same conclusion. Furthermore, literature shows that analysing yield curves based on duration rather than maturity generate better bond price forecasting results (Hopewell and Kaufman, 1973). Yawitz (1977) state that bond price volatility is determined by two factors i) yield volatility and ii) bond's duration. While the former is market-determined the latter is a mathematical expression to capture the effect of shift in yield curves on price volatility.

Authors in the past have tried to establish a relationship between the arrival of 'news' and its affect on the yield curve. Economic events trigger unexpected changes in the underlying variable, affecting an asset's cash flows and also the discount rates used to value these cash flows. Urich and Wachtel (1984) and McQueen and Roley (1993) show that the producer price index (PPI) impacts bond prices by affecting interest rates. Roley and Troll (1983) provide evidence that the industrial production index influences interest rates. Studies further show that the consumer price index (CPI), unemployment rate and balance of trade have a significant effect on interest rates, which determines bond price volatility (Hardouvelis, 1988; McQueen and Roley, 1993). Hardouvelis (1988) also provide evidence of disposable income, retail prices and demand of durable goods to have an impact on interest rates.

A related line of literature looks at future markets using intra-day price information data. Examples include Ederington and Lee (1993) and Harvey and Huang (2002). Specifically they study the impact of economic news release on Treasury bond and Eurodollars. The findings confirm the results of the previous studies. CPI, PPI, unemployment rate and demand for durable goods have significant volatility effects on interest rates, affecting futures prices. However, evidence shows that yields have changed in ways not fully addressed by theory. To address this issue, Cox et al. (1985) and Vasicek (1977) employ a single factor model to study the effect of short-term interest rate. Brennan and Schwartz (1979) uses two-factor model to examine the effect of economic factors on long-term interest rates. Elton et al. (1996) study the spread between short-term and long-term interest rates using a similar two-factor model. They use two intermediate maturity bond yields as a proxy for the short-term interest rate volatility. In a similar vein, Balduzzi et al. (1996) employ a three-factor affine term structure model to examine short-term interest rates, long-term or the mean interest rate and volatility of the mean of the short-term interest rates. They conclude that only short-term rate is significant across bond yields with all maturities.

Arguing from a classical standpoint, a nominal interest rate can be decomposed into a real interest rate and an inflation component that consists of an inflation premium and expected inflation. Theories that relate to determination of interest rate consider real interest rate as intertemporal marginal rates of substitution such as consumption growth rates. In production-based models, Breeden (1986) and Cochrane (1991) use marginal growth rates of transformation, i.e. expected output growth rates, as a measure of real interest rate. Liquidity-preference models consider the role of central banks in controlling the nominal and real interest rates. In traditional quantity theory, money supply and business cycle are related to inflation, whereas in the Phillips-curve point of view inflation is tied to the economic cycle. This emphasises that the economic factors and news announcements, which affect bond price volatility are still not clearly theorised.

2.3 Stock-Bond Return Co-movements

The literature on SB return co-movements has received much attention over the last few years. Many academics have attempted to explore the co-movement of stock-bond

returns. Shiller and Beltratti (1992) employ a dynamic present value model to conclude that annual stock-bond correlation of U.S. and U.K. data are abnormally high to be explained by a theory. Campbell and Ammer (1993) adopt the same method to estimate the variances and co-variances of post-war U.S. monthly stock and bond returns. Both studies assume return co-movement as time-invariant. Yet, Barsky (1989) provides a theoretical justification for SB asset-correlation. He states that the co-movements are state-dependent. In particular, he identifies that diminishing productivity growth and increasing market uncertainty have a negative influence on firm profits and real interest rate, which drives stock and bond prices to vary inversely.

Researchers moved in the direction of identifying and investigating the time-invariant characteristics of SB return volatility. Scruggs and Glabadanidis (2003) reject models that impose time-independent correlation restriction on SB returns covariance matrix. Fleming, Kirby and Ostdiek (1998) study the influence of information flow on volatility of stock, bond and money markets. They associate the link between information flow and volatility, but do not explore in depth the specific information that causes the SB return covariance. Officer (1973) and Schwert (1990) attempt to explain the changes in SB return volatilities by examining macroeconomic state variables. The studies found weak relationship between macroeconomic variables and stock volatility, but failed to establish any significant relationship with specific variables. Yet, David (2008) shows that uncertainty about inflation and firm earnings explain some changes in SB return volatility and co-movement. Stivers and Sun (2005) employ regime-switching models to analyse short-run dynamics of SB co-movements. More precisely, they investigate the “flight to quality” issue by examining the impact of stock market volatility on bond yields. In a similar vein, Gulko (2002) uses the same methodology to confirm that significant changes in SB co-movement patterns around an economic crisis.

A related stream of literature considers high frequency data to examine how short-run SB price movements are influenced by news announcements. Examples include Fleming and Remolona (1999), Balduzzi et al. (2001), Fair (2003), Andersen et al. (2005) and Andersson et al. (2008). In particular, these studies provide important insights on price adjustments, but fail to explain long-run asset return co-movements.

3 Methodology

This section discusses the methodology used to develop this systematic literature review. Consistent with Tranfield et al.'s (2003) methodology for developing 'evidence-informed management knowledge', I elaborate in detail on the steps taken in conducting this study.

3.1 Rationale for Systematic Review

Stemming from medical science, systematic reviews are a new phenomenon in social science research. Alternative to a traditional narrative literature review, the methodology of the systematic review incorporates a precise review protocol, which provides an "audit trail of the reviewers decisions, procedures, and conclusions" (Cook et al., 1997, in Tranfield et al., p. 209). In order to avoid biases the systematic review process ensures that the methods of selecting and evaluating literature are explicitly reported.

The value of a systematic review can be justified on the grounds of four main issues. First, it follows a rigorous and transparent process that minimises the limitations of a traditional narrative-based review. The latter provides a partial picture, which suffers from the reviewers' diverse biases such as "their own pet theories, [...] funders, [...] or] the perceived need to produce positive findings in order to get published (Petticrew and Roberts, 2006, p. 5). Second, a review of a single study is seldom conclusive and "the amount of conflicting information often makes deciding where the 'balance of evidence' on any question lies difficult" (Petticrew and Roberts, 2006, p. 22). Alternatively, the systematic review approach allows researchers to draw conclusions based on relevant and quality evidence (Tranfield et al., 2003). Third, the systematic review enables the researcher to get a comprehensive picture regarding a specific phenomenon by summarising evidence and differentiating explanations among studies. Forth, it provides avenues to oppose the established paradigms and 'schools of thought' through a rich and meticulous investigation of the existing evidence, which underpins a specific social phenomenon. This further facilitates in scoping future research directions to advance theory building (Petticrew and Roberts, 2006). A systematic review, therefore, involves scientific strategies to limit bias, assemble, critically analyze and

synthesise relevant studies that dwell upon a specific phenomenon on interest. These details are discussed next.

3.2 The Consultation Panel

To contribute to the quality and validity of the systematic review, I relied on a review panel consisting of both academicians and practitioners. Consequently, this will “help direct the process [...] and resolve any disputes over the inclusion and exclusion of studies” (Tranfield et al., 2003, p. 214). The table below provides an overview of the panel members and their respective roles.

Table 3-1: Consultation Panel

Person	Title/Organization	Role
Prof. Sunil Poshakwale	Professor of Finance, Cranfield School of Management	Supervisor
Dr. Yacine Belghitar	Senior Lecturer in Finance, Cranfield School of Management	Internal Advisor & Panel Member
Dr. Stephanie Hussels	Lecturer in Entrepreneurship, Cranfield School of Management	Systematic Review Expert
Dr. Antti Imanen	Managing Director, AQR Capital Management (Europe) LLP.	External Advisor
Heather Woodfield	Social Science Information Specialist, Cranfield School of Management	Literature Search Advisor

3.3 Search Strategy

In an effort to produce a thorough literature review it is pertinent to develop a sound and robust search strategy. The flow chart below gives an account of my search strategy.

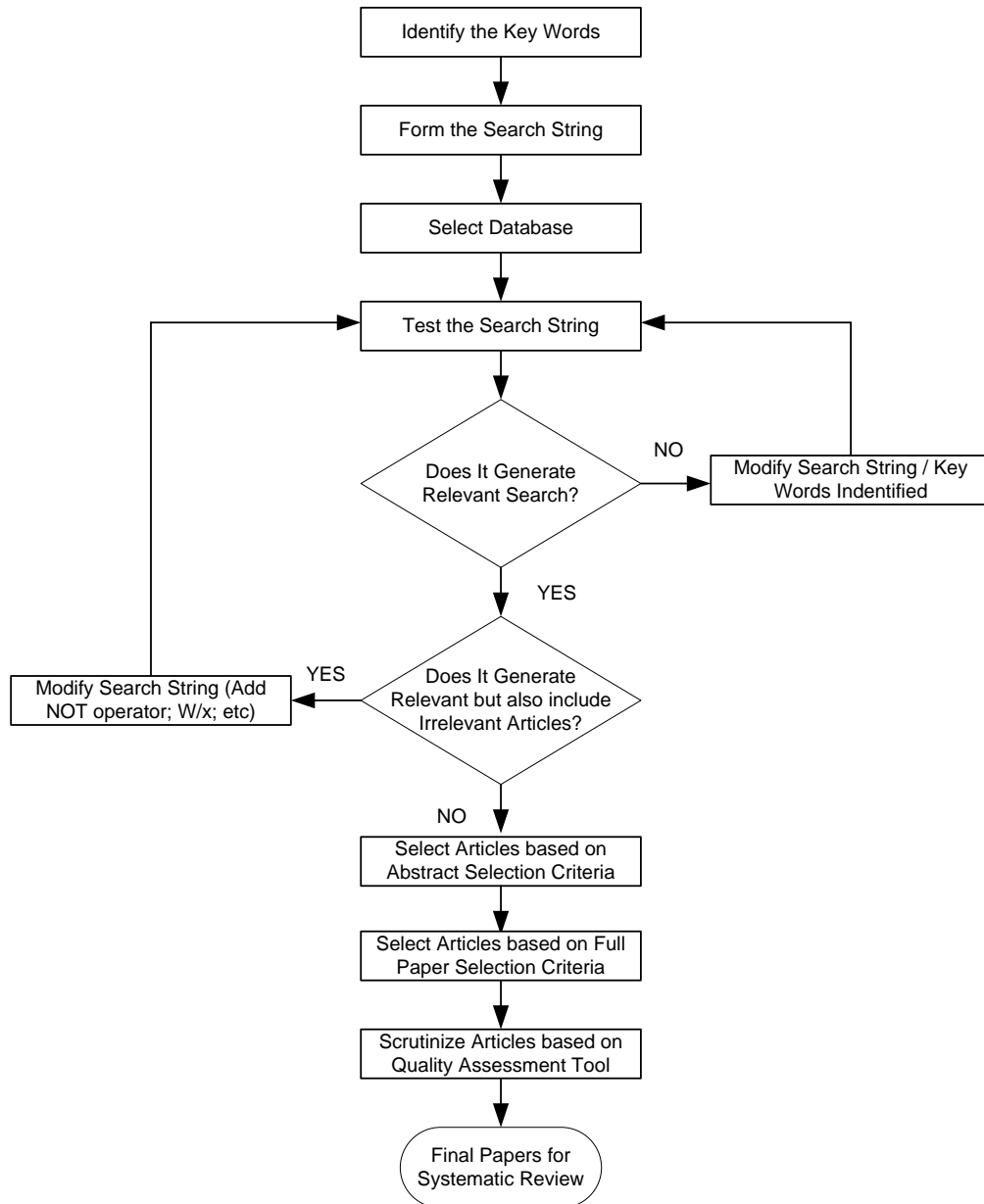


Figure 3-1: Search Strategy

My search strategy included the identification of search strings and keywords. I searched three databases and identified additional publications through cross-referencing.

3.3.1 Key Word Search

The table below illustrates the various key words that I have used to develop my search string. Key words are categorized based on the thematic areas defining my review question.

Table 3-2: Search Strings

No.	Strings
1	stock-bond or “Stock and Bond” or stock w/5 bond
2	correlat* OR co-varia* OR covaria* OR co-movement OR comovement OR volatil*
3	futures OR gold OR options OR oil OR commodities OR CDS OR Real Estate

The final string is as follows: String (1) AND String (2) NOT String (3). This results in:

all (stock-bond or “Stock and Bond” or stock ws bond) AND all(correlat OR co-varia* OR covaria* OR co-movement OR comovement OR volatil*) NOT all(futures OR gold OR options OR oil OR commodities OR CDS OR Real Estate)*

In order to exclude papers relating to others fields of finance, I included the NOT operator in the search string. It includes futures, gold, options, oil, commodities and real estate. This was developed through an iterative process. An illustrative example of the preliminary search results is shown below.

Table 3-3: Illustrative Preliminary Search Results

Search	String	Database	No. Of Articles
1	<i>all(stock-bond) AND all(correlat* OR co-varia* OR covaria* OR co-movement OR comovement OR volatil*)</i>	ABI ^a	85
2	<i>all(stock-bond or “Stock and Bond”) AND all(correlat* OR co-varia* OR covaria* OR co-movement OR comovement OR volatil*)</i>	ABI ^a	607
3	<i>all(stock w/5 bond) AND all(correlat* OR co-varia* OR covaria* OR co-movement OR comovement OR volatil*) NOT all(futures OR gold OR options OR oil OR commodities OR CDS OR Real Estate)</i>	ABI ^a	233
4	<i>all (stock-bond or “Stock and Bond” or stock w/5 bond) AND all(correlat* OR co-varia* OR covaria* OR co-movement OR comovement OR volatil*) NOT all(futures OR gold OR options OR oil OR commodities OR CDS OR Real Estate)</i>	ABI ^a	345

^a The articles pertain to ABI/Inform Complete Scholarly Journals

3.3.2 Resources

For the literature search I draw on three databases namely EBSCO, ABI and Scopus. Table 3-4 gives a description of them. A preliminary search revealed that EBSCO and ABI contain a substantial amount of the relevant literature. Hence, it was redundant to include additional databases such as Science Direct and Emerald. Yet, addressing the

recommendation of Ms Heather Woodfield, I included Scopus to identify additional publications. This being said, Scopus did not lead to the identification of additional articles.

Table 3-4: Databases

Database	Description
EBSCO Business Premier	The world's largest full text database covering 2,950 scholarly business journals and comprehensive full text coverage for regional business publications. Abstracts are available from the year 1886 for important scholarly periodicals.
ABI/INFORM Global	Provides a wide range of information covering over 3,750 publications. The coverage years span from 1923 till present.
Scopus	World's largest abstract and citation database for peer-reviewed journals

3.4 Selection Criteria

The search based on the above mentioned criteria yielded a large number of papers. These papers were then scrutinised in a two step process based on the criteria illustrated below to be included in the systematic review. First, the abstracts were evaluated. Second, the full texts were screened.

3.4.1 Selection Criteria for Abstracts

The selection criteria for the abstracts were based on six key dimensions. These are illustrated in the table below.

Table 3-5: Selection Criteria for Abstracts

Criteria	Variables	Rationale
Topic	Stock-Bond Return Correlation	The review aims to illustrate the findings and claims made by different authors explaining the stock-bond return comovements. Therefore, multi-asset correlations and comovements between other asset yields are excluded.
Explanatory Variables	Macroeconomic Variables and announcements	The review includes papers that seek to explain the key issue considering macroeconomic variables and announcements as the exogenous variables.
Time Period	From the origin of Modern Portfolio Theory (1952) till date	The review includes all relevant papers that aim to explain the key issue (stock-bond return correlation).
Academic and Scholarly Journals	Peer reviewed journals	The literature review only includes articles from peer-reviewed scholarly journals. Working papers and conference proceedings will not be investigated as they are

		not peer-reviewed and the good ones will turn into papers eventually that shall be reviewed in my analysis.
Economies	Developed and emerging economies	The review includes papers concerning both developed and emerging economies to address the two sub-questions: i) Are the effects of macroeconomic variables on SB returns in different economies common? and ii) What are the effects of global integration on SB return correlation?
Approach	Empirical and Theoretical	The review includes both the approaches to illustrate and report the findings pertaining to the third sub-questions, i.e. How can the influence of macroeconomic variables on SB return correlation be modelled?

3.4.2 Selection Criteria for Full Papers

After the papers were selected based on abstracts they were then filtered on the basis of full paper selection criteria and quality assessment test to be subsequently included in the review.

Table 3-6: Selection Criteria for Full Papers

Theoretical/Conceptual Papers must contain:	
<ul style="list-style-type: none"> • The relevant theoretical background and the link of the model(s) developed to these theories should be clearly discussed • Assumptions underpinning the model(s) developed should be clearly stated • The variables, parameters and the equations of the model(s) should be clearly defined and stated. • Proofs and discussions of the critical result(s) and theorem(s) should be provided • The limitations of the model(s) should be stated • The findings of the model(s) should be adequately warranted, providing empirical evidences or real time events. 	
Empirical Papers must contain:	
<ul style="list-style-type: none"> • The empirical work should be aligned with existing theories and / or previous empirical work(s) • A clear description of sample used, stating the time period, context, etc. and its validity for generating conclusions • Variables should be clearly defined and explained • The methodology used should be clearly explained, providing its advantages and limitations • Results should be properly explained and discussed • Results should be aligned to the aim of the research • The claims and contributions of the study to the current understanding of the field should be properly stated with adequate warranting, highlighting the generalisability of the findings. • The study should highlight potential areas of future research. 	

3.4.3 Quality Appraisal

For the papers to be finally included in the literature review, all relevant full papers selected had to meet the quality appraisal requirements. The details of the quality assessment protocol are shown in Table 3-7: Quality Assessment Tool. Only papers with total scores above four were included in this study.

Table 3-7: Quality Assessment Tool

Factors	Levels		
	Low or Absent (0)	Medium (1)	High (2)
Theoretical Background	Absence or insufficient description of theoretical background	Basic Review of theoretical background or summary of empirical articles	Sufficient review of theoretical foundations; research question aligned to the theory; adequate report of previous empirical work
Methodology	No explanation of the methodology applied	Acceptable level of research design and methodology used	Clear description of why the methodology is applied and its alignment with the theoretical background and research question; all variables and proxies clear explained
Data Set	Proper description of data not provided; time period considered not justified	Adequate description of data set; adequate sample size	Clearly explained data set and its purpose to answer the research question; reason for considering the time frame is clearly mentioned
Data Analysis and Findings	Results are inadequately described; findings fail to answer the research question	Findings are able to answer the research question	Results are clearly explained; findings are justified by the use of appropriate statistical measures; findings relate to the research aim; results are adequately warranted
Contribution to Knowledge	No theoretical or empirical contribution	Reasonable contribution to existing body of literature	Major contribution to existing body of literature
Limitations and Scope for Future Research	Limitations and future scope of research neglected	Limitations not clearly aligned to the research aim and methodology; scope for future research not stated	Limitation of the study clearly stated; shows direction for future scope of research

3.5 Cross Referencing

Cross-referencing is an effective way to identify relevant papers. The full papers selected through the selection criteria were used to identify relevant papers through cross-referencing. The papers identified through this mechanism were then passed through the same selection criteria to be finally included in the systematic literature review.

3.6 Selected Articles

The table below reports the overview of the screening process illustrated in this section.

Table 3-8: Overview of the Systematic Literature Review Methodology Process

Data Source	Records from the Search Strings	Abstract Selection	Full Paper Selection	Quality Assessment Selection	Inclusion of Cross Referencing	Total after Elimination of Duplicates
ABI	345	62	55	43	6	56
EBSCO	853	175	50	50		
Scopus	316	43	43	38		

The procedure of search and qualitative assessment yielded a final number of 56 articles. The majority of the papers were eliminated as they failed to address the concerned review question. None of the papers were rejected based on their year of publication and language. It is noteworthy that six papers were included from cross-referencing. Yet, all these papers had to fulfil the quality assessment criteria.

3.7 Data Extraction for Accepted Papers

After the final selection of the articles to be reviewed, they were imported to EndNote, a citation management software. Relevant data were then extracted from the selected articles for the subsequent analysis and synthesis. The following table provides the extraction form that was used for data mining.

Table 3-9: Data Extraction Form

Citation
Title:
Author(s):

Journal / Source:
Year:
Key words:
Study Background
Research Question(s):
Data Description:
Time Period:
Methodology
Model Employed:
Empirical Contribution
Economy:
Explanatory Variables:
SB Return Correlation:
Synthesis
Key contribution(s) to review question:
Comments/observations/notes:

The extracted contents of the selected papers are presented in Appendix-A.

3.8 Data Synthesis

The information extracted from the final papers selected for the review were then used to present a coherent synthesis as discussed in section 5. The purpose of data synthesis is threefold: i) provide a clear description of the literature reviewed, ii) state the research gaps and iii) provide an argument, justifying my subsequent research question as discussed in section 0.

Next, I turn my focus to report a descriptive account of the papers included in this review before I discuss the thematic findings in section 5.

4 Descriptive Account of the Literature

This section presents the characteristics of the literature reviewed in this study in two distinctive parts. The first part relates to the publication features. The four characteristics discussed here relate to i) journals, ii) historical evolution of the research phenomenon, iii) methodologies adopted and iv) the data used by the authors to substantiate their findings. The second part gives an account of the three principle domains in which the articles can be compartmentalized.

4.1 Journal Characteristics

Figure 4-1 shows the wide range of different publications reviewed in this study. All of them are peer-reviewed journals, which publish theoretical and empirical research in the field of financial economics. Some of the journals included in this study relate specifically to finance, e.g. *The Journal of Finance*, *Journal of Finance and Quantitative Analysis*, while the others belong to the area of economics, e.g. *The American Economic Review*, *Journal of Business and Applied Economics* and *Journal of International Economics*.

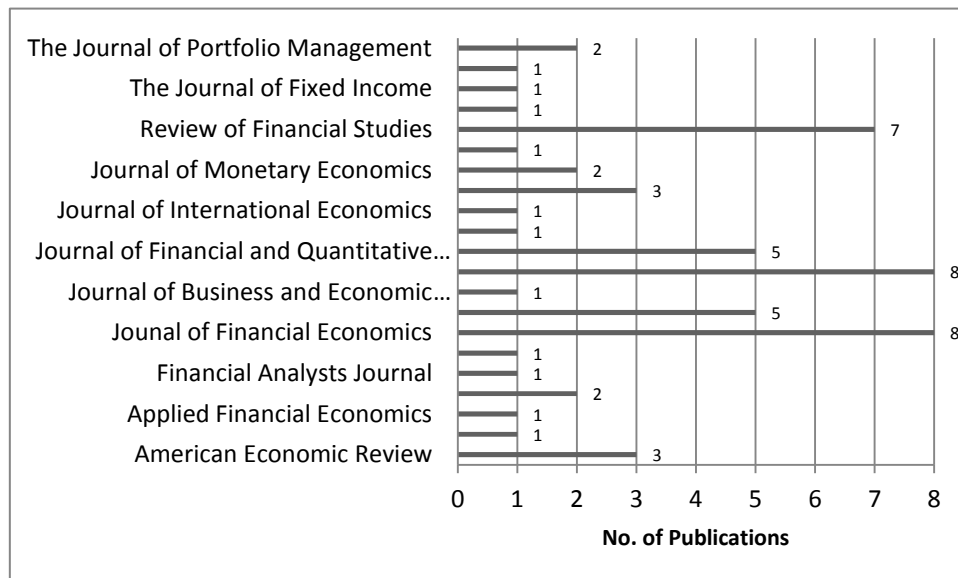


Figure 4-1: Journal-wise Distribution of Publications

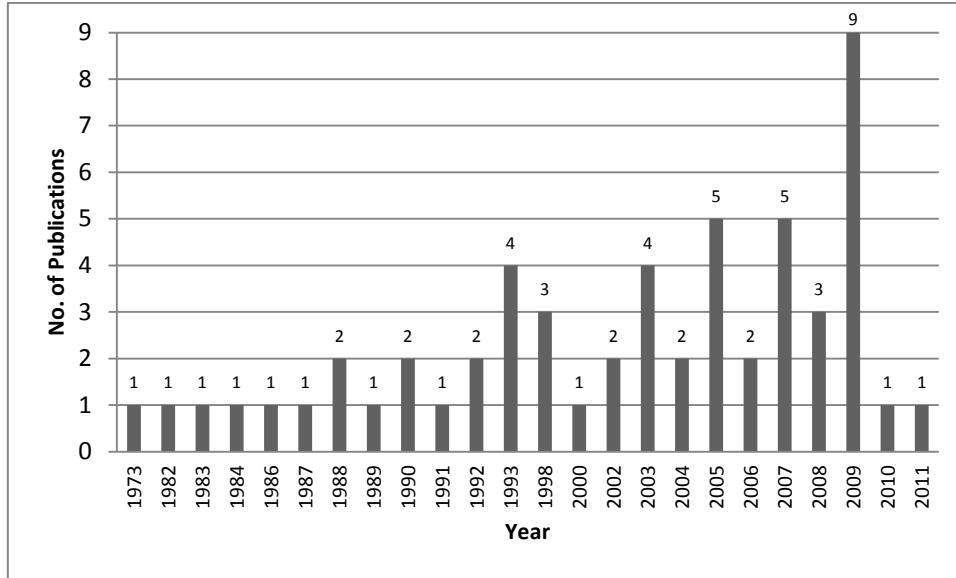


Figure 4-2 below shows the number of studies that have been published over the years relating to SB return co-movements. It is evident that this field is among one of the most widely researched areas in the field of capital markets. Studies related to emerging theoretical concepts and also prescribe recommendations for practitioners, especially in the domain of portfolio management.

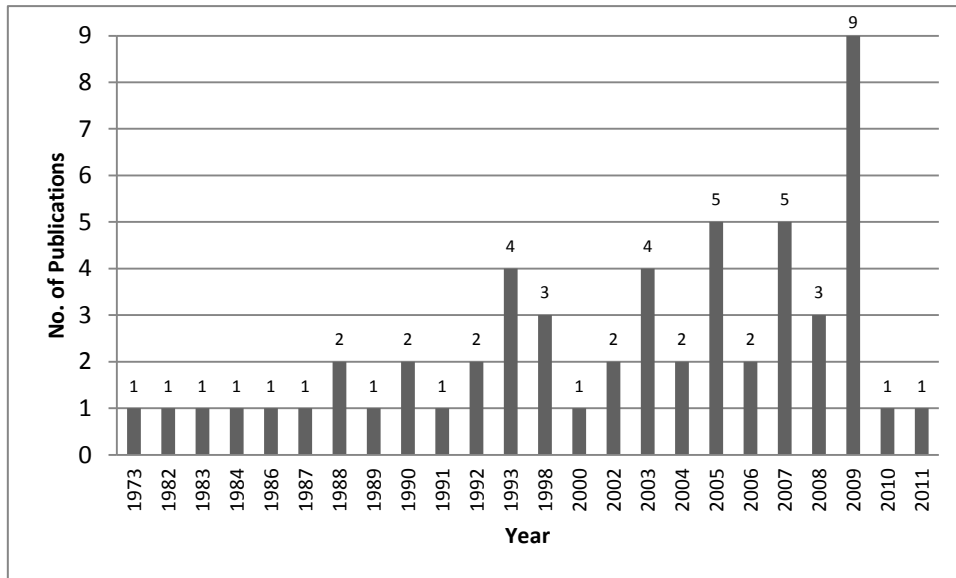


Figure 4-2: Year wise Distribution of Articles

The philosophical stances adopted by the authors are homogeneous across the different studies published in various scholarly journals. All of them relate to the positivist research paradigm adopting a realist ontology and an empiricist epistemology. All

authors employ different quantitative methods for their empirical analysis. Figure 4-3 reports the various methods used to study SB return co-movements.

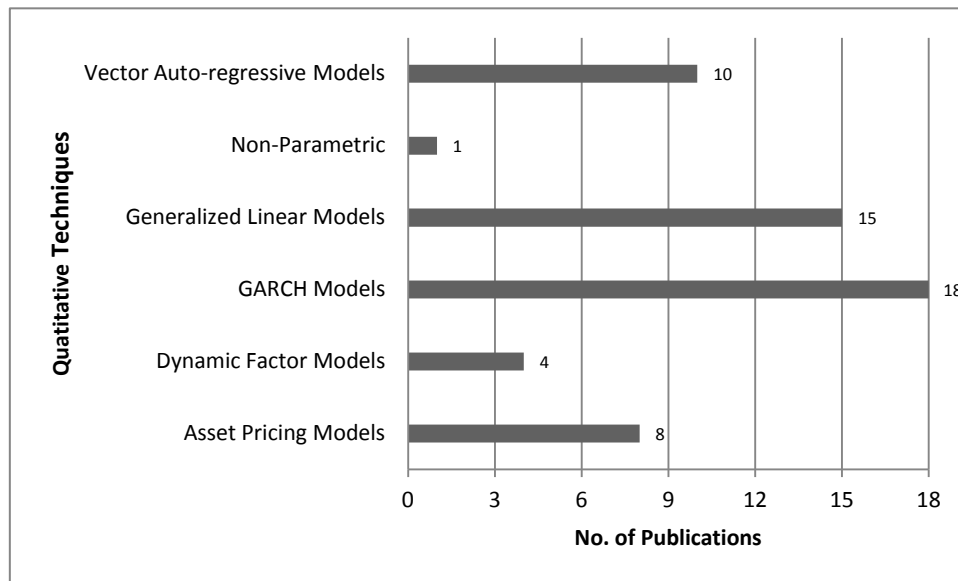


Figure 4-3: Description of Quantitative Techniques

The studies primarily relate to developed economies. Table 4-1 shows the distribution of empirical data used in exploring the SB return correlation phenomenon.

Table 4-1: Description of Data Used

Data Used			No. of Articles
Countries	Type of Data	Frequency	
U.S. German, British	Futures Market	tick-by-tick	4
U.S. German, British	Index	Daily	1
U.S.	Index	Daily	16
Emerging Economies	Index	Monthly	6
U.S.	Index	Quarterly	13
Developed Countries	Index	Weekly	12
Developed & Emerging	Index	Monthly	1
Theoretical			3

It is evident that nearly 82 percent of the studies have been conducted on developed economies whereas only 11 percent analyse the phenomenon in emerging economies. Far less research – merely two percent – have been done which take into consideration both developed and emerging economies. Extant literature, therefore, lacks in analysing the impact of financial integration which considers both developed and developing countries.

4.2 Description of the Studies' Content

The content of the studies can, be divided in to three principle components i) data used, ii) methodology employed and iii) explanatory variables considered. Table 4-2 provides an illustrative example of the articles studied.

Table 4-2: Extract of the Studies' Content

Ref. No.	Authors	Data	Methodology	Explanatory Variables	QAS
1	Andersson et al.	U.S., UK, Germany (daily data)	GARCH	Inflation, expected economic growth, perceived stock market uncertainty	1,1,2,2,2,1 (9)
2	Baele et al.	US (daily data)	Dynamic Factor Model	Inflation, expected economic growth, cash flow growth, risk aversion, interest rate	2,2,2,1,1,2 (10)

The quality assessment scores (QAS) reported in the table justify the inclusion of the papers in this systematic review. The individual scores reflect the respective assessment of each of the components as reported in Table 3-7. The aggregate score is presented in parentheses. To exemplify, Andersson et al. (2008) provide a basic review of the theoretical background. They fail to report the essential findings of Bekaert et al.(2007), Barsky (1989), which reveals the time varying dynamics of interest rate in relation to inflation and monetary policy. Thus, the study earns a score of one in the first category, theoretical background, of quality assessment. Concerning the second category, methodology, the authors do not explicitly report why they had selected the GARCH method to estimate the time varying dynamics of SB returns. Consequently, the score for this criterion is one. Yet, the paper precisely reports the data used and discusses in details the findings and the contribution of the research. Hence, each of these three criteria, i.e. data, findings and contribution of the study earn a score of two. The paper gets a score of one in the next criterion as it fails to clearly state the limitations of the methodology and scope for future research. This brings the aggregate score of Andersson et al.'s (2008) paper to nine. Likewise, the QAS for each of the selected article is presented in Appendix-A.

The next section discusses the thematic findings of the literature that relate to my review question.

5 Thematic Findings

In this section I present the main arguments in the literature in three distinct but complementary perspectives. First, I cast a review on the literature relating to the macro-economic variables that influence the SB return co-movements. Second, I focus on the effect of financial integration on co-movement of SB returns. Third, I review the various methods employed to model the time-varying SB return correlation. The key contributions of the SB return co-movement literature are presented in Appendix-B.

5.1 Macro-economic variables and SB return co-movement

Connolly et al. (2005; 2007) inform that SB return correlation varies inversely with stock market volatility. They justify their findings based on the ‘flight to quality’ phenomenon. Their analysis is on high frequency, daily U.S. market data. In a similar vein, Kim et al. (2006) confirm the role of stock market volatility on SB return co-movements in many European markets. They consider a number of economic state variables related to the convergence of the European Monetary Union. Addressing the issue in more depth, d’Addona and Kind (2006) show that real interest rate and inflation volatility influence SB correlation. While the former economic variable has a positive effect on SB co-movement in G7 countries, the latter decreases the asset-return correlation. Guidolin and Timmermann (2005) explore the monthly SB correlation of UK stock and bond markets. The correlations are positive and significant in the bull market while the reverse trend is more observable in the bear market. However, they exogenously determine the bull and bear states of the market, rather than deriving them from some economic state variables.

Boyd et al. (2005) and Andersen et al. (2007) analyse the influence of macroeconomic news announcements on SB markets. They state that discount rate effects drive positive correlation between the markets during economic expansions and cash flow effects have the reverse influence during recessions. Ilmanen (2003) considers i) business cycle, ii) inflation, iii) volatility and iv) the monetary policy setting to explore influence positive and negative SB return comovements and emphasises similar arguments. In contrast, Jensen and Mercer (2003) argue against the ‘flight to quality’ phenomenon to state that

SB correlations are higher in recessions than during the expansion phase. Their results are statistically significant for small-cap stocks only.

Schwert (1990) considers macroeconomic volatility, economic activity, financial leverage and trading activities as the various static variables to have influence on volatility of stocks. Wainscott's (1990) approach to predict correlations between U.S. common stocks and bonds considers the dividends and interest rates as the primary factors for pricing of stocks and bonds. Downing et al. (2009) consider expected cash flows to explain the low correlation between high-grade bonds and equity returns. Similar to Ilmanen (2003), Baele et al.'s (2009) model considers interest rate, inflation¹, cash flow growth² and the output gap³ as the economic variables. Moreover, they also take into account some additional factors such as risk aversion⁴, liquidity proxies⁵ and inflation uncertainty to view their results on stock-bond return correlation. Brenner et al. (2009) consider the total consumer price index, payroll changes and unemployment news for their study on the effect of macroeconomic news release on U.S. financial markets. Moreover, literature on bond and equity markets (Amihud, 2002; Kamara, 1994) has identified specific macroeconomic state variables that influence SB return co-movements, which I discuss next.

5.1.1 Standard Macro Factors

The macro factors generally include the following state variables: inflation, interest rate and output gap. These variables predominantly affect both cash flows and discount rates; hence it is not always easy to predict their impact on SB returns. Owing to the fact that bonds have predetermined fixed cash flows, inflation influences stocks and bond returns differently. Analogously, since an output gap is associated with dividends, they should influence stock returns but not fixed income securities (Baele et al., 2009).

However, the term structure of interest rates is affected by both inflation and output gap. Therefore, the two state variables, i.e. inflation and output gap, affect both stock and

¹ Inflation is calculated as the log difference of the consumer price index.

² Cash flow growth includes dividend growth including repurchases (Bekaert and Engstrom, 2010).

³ Output gap is the rate of difference between the gross domestic product and its quadratic trend.

⁴ Risk aversion factor is calibrated based on Campbell and Cochrane's (1999) framework.

⁵ Liquidity proxies are estimated based on Carr and Wu's (2009) framework.

bond prices. But, since equities are a claim on real assets, expected inflation should not influence the discount rate on stocks. Yet, a recurring finding by Fama and Schwert (1977) state that stock returns are negatively correlated with expected inflation. This also suggests that equities are inadequately hedged against inflation shocks. Campbell and Vuolteenaho (2004) interpret this as money illusion, whereas Bekaert and Engstrom (2010) argue that inflation and risk premiums are correlated. In order to account for risk premium, authors use a number of direct ‘economic’ risk proxies, which I discuss next.

5.1.2 Risk-premium Factors

Authors use various measures of economic uncertainty and risk aversion as estimates of SB risk premiums. Bekaert et al. (2009) illustrate that stochastic risk aversion significantly influences positive SB return correlation. They also highlight the increasing level of complexity that arises in analysing the effects on risk aversion. Wachter (2006) shows that risk aversion is positively related to SB premiums, but its effect on interest rates is ambiguous. But, because of the effects of consumption smoothing and precautionary savings, a rise in risk aversion may increase or decrease interest rates respectively. Bekaert et al. (2009) provide evidence for economic uncertainties, which impact risk-premiums and asset valuation. Through the precautionary savings effect an increase in economic uncertainty will lower the interest rates. Hence, it leads to an ambiguous effect on equity valuation that is often considered to be negatively affected with changing economic conditions. Therefore, economic uncertainty can drive SB returns in the opposite direction depending on the effects of term structure and risk-premium.

David (2008) provides an alternative illustration for the use of uncertainty measures. He shows that higher economic uncertainty triggers investors to react more swiftly to information and therefore has a profound effect on asset return covariances.

Baele et al. (2009) uses the empirical proxy of risk aversion based on Bekaert and Engstrom’s (2010) model, which is created using Campbell and Cochrane’s (1995) external habit specification. This fundamental risk aversion proxy is based on historical consumption growth data. Since it behaves counter cyclically it is unlikely to capture complete variations in equity risk-premiums. Bollerslev et al. (2009) show that variance premium has predictive power for forecasting stock returns. Drechsler and Yaron (2011)

include additional non-Gaussian components in the consumption growth model. Employing their extended model, they show that risk aversion and nonlinear components significantly influence variance premium. In contrast, Connolly et al. (2005) use an implied volatility estimate as a proxy for stock market uncertainty. They report that SB co-movements are inversely related to stock market uncertainty. This can be justified as ‘flight to safety’, where investors switch from risky assets to other alternative financial instruments which ensures secured returns. Yet, it is not clear whether this effect is due to the market uncertainty or rather reflects on the risk-premium component of the estimating model.

5.1.3 Liquidity Factors

Liquidity affects SB pricing in two central ways. First, it affects the betas, which contributes to the factor exposure effect as observed returns may fail to quickly respond to economic shocks in illiquid markets. Second, economic shocks that increase liquidity may have a positive impact on asset returns. This corresponds to the liquidity price factor. Therefore, the impact of liquidity on SB return co-movement depends on how liquidity shocks vary across markets. For example effects of liquidity may associate with ‘flight to safety’ phenomenon. In periods of economic crisis, investors may move from less liquid stocks to treasury bonds. Consequently, the resulting price pressure effect may trigger negative SB returns co-movement. Monetary policy can affect liquidity in both stock and bond markets. It may increase borrowing constraints or trigger trading activity, influencing SB returns to co-vary. Existing studies by Chordia et al. (2005) and Goyenko et al. (2009) are rather inconclusive in accounting for these liquidity effects.

To address this issue, Baele et al. (2009) consider unconstrained proxies of liquidity shocks in their estimation model. They use Goyenko et al.’s (2009) proxy for bond market illiquidity and equity market illiquidity proxy based on Bekaert et al.’s (2007) ‘zero return’ concept. This measure positively correlates with Amihud’s (2002) and Hasbrouck’s (2009) price impact and effect cost measures respectively.

5.2 Effect of Financial Integration on SB Return Co-movement

Global integration of financial markets led to opening up of emerging economies to foreign portfolio investment. This enabled portfolio debt and equity flows in emerging markets. This triggered market participants and policy makers to closely watch the cash flow movements in these emerging globally-integrated financial markets. Consequently, researchers have examined the dynamic relationship of SB return co-movements in this emerging global environment.

Over the decade, academics have investigated the impact of stock market integration and liberalization of emerging economies. Examples include Bekaert et al. (2009; 2007) and Henry (2000), Bekaert and Harvey (2000), Patro and Wald (2005) and Kim et al. (2006). Researchers have also examined asset pricing implications of these globalized financial markets (Carrieri et al., 2007). Yet, the literature on impact of market integration on cross-asset relationship is still in its infancy.

Current literature separates market integration from SB return co-movements within the same economy. Therefore, I address the relevant pieces of literature separately.

5.2.1 Financial Integration

Financial market integration is a slow process that evolves over time. Liberalisation of emerging economies may also face short-term reversals. To study this phenomenon existing studies employ two broad alternative approaches. First, researchers use economic structural breaks on economic indicators to examine post and pre-liberalisation effects on emerging economies. The studies rely on the official liberalisation date to decide on the period of analysis. Examples include Henry (2000), Bekaert and Harvey (2000) and Bekaert et al. (1998). Second, studies are based on Edison and Warnock's (2003) approach to measure the 'intensity of capital control' by foreign investors.

Henry (2000) and Bekaert and Harvey (2000) document that financial integration enables domestic investors to share their risk with foreign investors. While this reduces the cost of capital, it increases the aggregate level of investment. Bekaert et al. (1998; 2007), Edison and Warnock (2003), and Kim et al. (2006) illustrate positive impacts as a consequence of financial integration. They state that market integration leads to

information disclosure and reduction in agency costs, triggering increase in real economic growth, decline in stock market volatility and increase in correlation of beta with world financial markets. De Jong and De Roon (2005) also highlight an improvement in corporate governance mechanisms due to financial integration.

Moving on to asset pricing, Bekaert et al. (2009), Bekaert and Harvey (2000), Carrieri et al. (2007) and De Jong and De Roon (2005) provide insights on transition of emerging markets to world capital markets. International asset pricing models (IAPM) provide estimates of integration-based market returns. In case of liberalised-emerging markets, the models assume that variance in segmented markets is dominated by covariance of integrated capital markets. This assumption is supported by the general framework provided by Bekaert et al. (1998). Carrieri et al. (2007) extends the partial integration concept of IAPM. They introduce an integration index as an exogenous variable, calibrated as the variance ratio of a managed portfolio to the overall country market index. De Jong and De Roon (2005) in their generalized CAPM, introduce a segmentation risk premium factor, which considers emerging market betas to co-vary with world market. This segmentation risk premium, which is priced into the liberalised-market stock returns, relate to the lack of hedging options of the investors for holding non-investible emerging-market assets. Their findings show that as the emerging markets become fully integrated, the cost of capital reduces. Yet, what remains unaddressed is whether this phenomenon impacts the stock market's relationship with other asset such as fixed-income securities.

5.2.2 SB Return Co-movements

The existing studies document how SB returns co-move over time, but not why the returns co-vary together. Early studies by Campbell and Ammer (1993) show that observed levels of SB return co-movements are large enough to be justified by economic fundamentals. They assume correlation of SB returns as time-invariant. Connolly et al. (2005) and Fleming et al. (1998) show that SB co-movement over long-term exhibit positive correlation, but the relationship is dynamic. This suggests that the asset allocation for portfolio diversification continuously changes. In a similar vein, Scruggs and Glabadanidis (2003) exhibit an analogous phenomenon for conditional SB variance in developed markets.

For emerging markets, Kelly et al. (1998) was the first study to examine SB return co-movements. They reveal that in emerging markets the co-movements are greater than in developed financial markets. They attribute it to the country risk in emerging economies and argue that bond investments behave ‘equity like’. Employing institutional investor ratings, Erb et al. (1999) confirm the high degree co-movements of SB returns. More recent studies explore the impact of government policies on SB returns. Li and Zou (2008) documents on the government policy decisions in China and its impact on SB co-movements. Boyer et al. (2006) examines the SB co-movements during a financial crisis. They state that a financial crisis spreads through investments in emerging market equities. Panchenko and Wu (2009) employ a semi-parametric approach to examine the effect of market integration on SB co-movements in emerging markets. Their results are generic, stating that emerging economies provide opportunities for enhanced portfolio diversification. The study does not specify specific factors that relate to the co-movement of SB returns.

Studies on the impact of information flow across asset classes show that shocks in one asset class produces cross-market volatility disturbances. This leads to a portfolio rebalancing (Chordia et al., 2005; Fleming et al., 1998). Chordia et al. (2005) and Connolly et al. (2005) emphasise the ‘flight to safety’ phenomenon. Investors move from risk assets to safer investment options, i.e. bonds in times of economic turmoil. This induces a negative SB return co-movement as the demand for bonds increases whereas the demand for stock decreases, imposing an opposing price pressure. More recent studies by Connolly et al. (2007) and Kim et al. (2006) examine the relationship between stock market volatility and SB return co-movements. They use equity index implied volatility estimates to capture economic uncertainty, which affects stock market volatility. In spite of these exiting studies the governing dynamics of SB co-movement are not sufficiently explained by theory.

5.3 Modelling the SB return co-movement

Post-1968 to 2009, U.S. market shows 19 percent correlation in SB returns (Baele et al., 2009). Shiller and Beltratti (1992) underestimate the empirical SB correlation by imposing constant discount rates in their present value model. In contrast, Bekaert et al. (2009) overestimate the co-movements employing a consumption based asset pricing

model. Yet, these methods provide substantial evidence of significant correlation estimates using economic state variables. The findings show (cf. Figure 5-1) that SB correlation is as high as 60 percent in the late nineties to as low as negative 60 percent in 2005. An increasing number of authors have documented this time-varying phenomenon using sophisticated statistical models (Guidolin and Timmermann, 2005), but much less research has been done to unravel the underpinning economic sources.

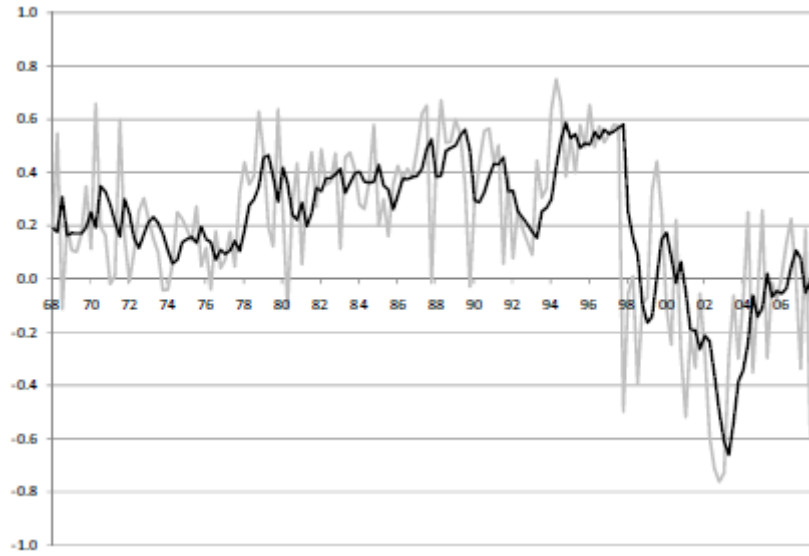


Figure 5-1: SB Return Correlation adopted from Baele et al. (2009)

In particular, Connolly et al. (2005) justify ‘flight-to-safety’ as the primary reason for low SB correlation since 1977. In this regard, authors have proposed various pricing models assigning latent variables to capture for negative SB co-movements.

Schwert (1990) uses 12th order autoregressive predictive models⁶ to calibrate the volatility estimates of i) stock returns, ii) bond returns and growth rates of i) the producer price index, ii) industrial production and iii) monetary base. Alternatively, Wainscott (1990) calculates the correlations based on rolling averages for the periods of one, three, five and ten years. He examines these correlations to test the predictive power of the future relations based on the historical relations. Ilmanen (2003) uses the

⁶ $\hat{\varepsilon}_t = \sum_{i=1}^{12} \gamma_i D_{it} + \sum_{i=1}^{12} \rho_i |\hat{\varepsilon}_{t-i}| + \mu_t$ where ε_t denotes the standard deviation and D_{it} is the capital gain including the dividends.

dividend discount model⁷ to find the correlation of the factors with the pricing of the asset classes. The model relies on the growth rate of the dividends, the government bond yield and equity risk premium to determine the factors that influence the stock-bond comovements.

Scruggs and Glabadanidis (2003) adopt a variant of two-factor Merton's ICAPM model to test for excess returns on stock and long-term bond portfolios. The authors use Kroner and Ng's (1998) asymmetric dynamic covariance (ADC) model to estimate conditional second moments. They also employ multivariate GARCH⁸ models to examine the pattern in which stock and bond markets react to return shocks and volatility. The ADC model takes into consideration the empirical characteristics⁹ of the data. The estimates of the models are calibrated using the QML¹⁰ method. Similarly Downing et al. (2009) adopt a bivariate vector autoregressive model¹¹ to calibrate SB return correlations. Baele et al. (2009) use a semi-structural regime-switching model to analyse the influence of the economic factors on SB return co-movements, which significantly increases the fit of the macroeconomic fundamental variables. The estimation of the model is similar to that of Scruggs and Glabadanidis (2003) using maximum likelihood functions. Brenner et al. (2009) use Engle's (2002) GARCH model to analyse the complex co-movement patterns and the impact of information arrivals on those patterns. Similar to the previous papers they estimate the models using Bollerslev and Wooldridge's (1992) QML model. Berben and Jansen (2009) employ Berben and Jansen's (2005) Smooth-Transition Correlation (STC) GARCH model to estimate the patterns and capture the structural shift where the rate of change of the

⁷ $P_s = E \left[\sum_{t=1}^T (1 + g/1 + Y + ERP_t)^T \times D \right]$ where P_s is price of a stock, g is the growth rate, Y is the short-term interest rate and ERP is the equity risk premium.

⁸ $\sigma_t^2 = \alpha_0 + \sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \beta_i \sigma_{t-i}^2$ where p is the order of the autoregressive conditional heteroskedastic term and q is the order of generalized autoregressive conditional heteroskedastic term.

⁹ Empirical characteristics include volatility clusters and time-varying correlations.

¹⁰ QML method stands for quasi-maximum likelihood method. It maximizes the objective parameter over a log-likelihood function of a parameter space.

¹¹ $z_t = c + \sum_{i=1}^L b_i R_{B,t-i} + \sum_{i=1}^L S_i R_{S,t-i} + \varepsilon_i$ where z_t is the vector $[R_{B,t}, R_{S,t}]'$, $R_{B,t}$ is the bond return and $R_{S,t}$ is the stock return.

transitional variable can be abrupt. Like the above studies, the model estimates the variable using maximum likelihood function.

Next, I discuss the general factor model, which is predominantly used to link SB returns to structural factors.

5.3.1 Dynamic Factor Model

The dynamic factor model is the most common method used to link SB return co-movements (Baele et al., 2009). The model is represented as:

$$r_t = E[r_{t-1}] + \beta_t F_t + \varepsilon_t \quad (5-1)$$

where r_t denotes excess equity and bond return matrix $r_t = (r_{s,t}, r_{b,t})$, $E[r_{t-1}]$ is the SB vector of expected SB returns, β_t represents the sensitivity to structural factor, F_t and ε_t is the vector of return SB shocks.

The time variation is sensitive to the structural factor, i.e. $\beta_t = (\beta_{s,t}, \beta_{b,t})$ is modelled as a function of an information set, I_t and V_t , which is a discrete variable that follows the Markov process. This variable is used to capture unexpected regime changes.

$$\beta_t = \beta(I_{t-1}, V_t) \quad (5-2)$$

The dynamic factor model assumes that the structural factors matrix (F_t) is normally distributed across a zero mean and its conditional variance (C_t), which represents a diagonal matrix.

$$F_t \sim N(0, C_t) \quad (5-3)$$

In particular, the conditional matrix is also influenced by V_t in the equation (5-2). The off-diagonal elements of C_t is zero, imposing the diagonal matrix to be orthogonal. The null hypothesis of (5-1) considers the residual SB returns covariance matrix to be homoskedastic.

The equation (5-1) implies that common economic factors affect SB return co-movements. If, we denote v_t as the realised instances of V_t , then the conditional variance of r_t can be represented as:

$$\text{cov}_t(r_t) = \sum \beta'_s(I_{t-1}, v_t) C(v_t | I_{t-1}) \beta'_b(I_{t-1}, v_t) P[v_t | I_{t-1}] \quad (5-4)$$

If the SB return covariance is independent of regime shifts, then (5-4) simplifies to

$$\text{cov}_t(r_t) = \beta'_{s,t} C_t \beta_{b,t} \quad (5-5)$$

In equations (5-4) and (5-5) the orthogonal variances matrix C is conditioned on the information set I_{t-1} . To estimate the conditional correlation between SB return co-movements, the covariance of the returns influenced by the state factors is divided by the SB return volatilities, i.e. $\sqrt{\beta'_{s,t} C_t \beta_{s,t} + e_s}$ and $\sqrt{\beta'_{b,t} C_t \beta_{b,t} + e_b}$ respectively, where e_s and e_b signifies residual SB returns of the model (5-1). The resulting SB conditional correlation equation is:

$$\rho_t(r_t) = \frac{\beta^1_{s,t} \beta^1_{b,t} \text{var}_t(F^1_t)}{\sqrt{\beta'_{s,t} C_t \beta_{s,t} + e_s} \sqrt{\beta'_{b,t} C_t \beta_{b,t} + e_b}} + \dots + \frac{\beta^n_{s,t} \beta^n_{b,t} \text{var}_t(F^n_t)}{\sqrt{\beta'_{s,t} C_t \beta_{s,t} + e_s} \sqrt{\beta'_{b,t} C_t \beta_{b,t} + e_b}} \quad (5-6)$$

Equation (5-6) reveals three stylized facts of the SB correlation estimate. First, variances of state factors have a significant effect on SB co-movement. Second, the impact of factor variance can be arbitrarily large on the correlation estimate, especially in case of an unexpected abnormal increase of variances. Third, the betas determine the direction of the SB co-movement. For example, if the betas for SB have the same sign, then increase in factor variances will generate substantial co-movement variation. Yet, for reverse co-movement, one of the betas must be negative and it should have a high relative co-variance with the state factors, which I discuss next.

5.3.2 Modelling the state variable dynamics

Hamilton (1989) introduced the modelling of the dynamics of the state variables. The general model for defining the dynamics of the state factors F_t is:

$$S_t = \Delta_1(V_t) + \Delta_2(V_t) E_t(S_{t+1}) + \Delta_3(V_t) S_{t-1} + \Omega(V_t) F_t \quad (5-7)$$

where Δ_1, Δ_2 and Δ_3 represent the drift vector, sensitivity to future expectations and feedback matrix respectively. The parameter Ω captures the contemporaneous correlation of the fundamental state variables. Thus, in equation (5-7) the state variable (S_t) depends on a latent regime discrete variable (V_t), which captures the structural changes in the macroeconomic relations. If we neglect the regime dependence the above equation reduces to a simple VAR with heteroscedastic shocks captured by Ω .

Some related literature further split the state variable vector into two components: ‘pure macro-state variables’ and ‘other-state variables’ (Baele et al., 2009; Goyenko et al., 2009). The former ($X_{t,m}$) is defined using the New-Keynesian model, whereas the shocks due to the latter component ($X_{t,o}$) is defined using a simple empirical model, which relates the other macro-state variables. In particular, Goyenko et al. (2009) employ a simple empirical model to show that bond liquidity is affected by macroeconomic variables such as monetary policy and inflation. The model is:

$$S_{t,o} = \Delta_{1,o}(V_t) + \Delta_{2,o}S_{t-1,o} + \Sigma_o^m S_{t,m} + \Omega F_{t,o} \quad (5-8)$$

where $\Delta_{2,o}$ captures the autoregressive dynamics of the state variables, Σ_o^m accounts for the contemporaneous covariance of macro-state variables and other-state variables and Ω is the vector of uncorrelated $F_{t,o}$ structural shocks. As in (5-7), here $\Delta_{1,o}$ accounts for the drifts in regime variables. Giordani and Soderlind (2003) and Evans and Wachtel (1993) show that inflation and output uncertainty are highly correlated with the macroeconomic heteroskedasticity. This justifies the inclusion of the parameter Ω . Hasbrouck (2009) illustrates that regime-dependent drifts capture structural changes, which affects the liquidity in SB markets.

The structural equation defining $X_{t,m}$ extends Bekaert et al.’s (2010) New-Keynesian model. To account for time-varying risk aversion, the model includes i) demand equation, ii) an aggregate supply equation and iii) an expected money supply behaviour parameter. Considering output gap (g_t), inflation (f_t), nominal interest rate (i_t) and risk aversion (a_t) as the four macro-state variables, $X_{t,m} = [g_t, f_t, a_t, i_t]$ can be defined as (Baele et al., 2009):

$$g_t = \phi_D + \xi E_t(g_{t+1}) + (1 - \xi)g_{t-1} + \varphi \alpha_t - \theta(i_t - E_t(f_{t+1})) + F_t^g \quad (5-9)$$

$$f_t = \phi_{AS} + \eta E_t(f_{t+1}) + (1 - \eta)f_{t-1} + \delta g_t + F_t^f \quad (5-10)$$

$$a_t = \Delta_a + \rho_a a_{t-1} + F_t^a \quad (5-11)$$

$$i_t = \phi_{MP} + \rho_i i_{t-1} + (1 - \rho_i)[\alpha(S_t^{mp})E_t(f_{t+1}) + \beta(S_t^{mp})g_t] + F_t^i \quad (5-12)$$

where ξ and η are captures the degree of expected-behaviour in demand and aggregate supply equations. The model guarantees endogenous persistence if the coefficients are not equal to one. The coefficient θ measures the impact on output due to changes in interest rate and δ , i.e. the effect on inflation due to output changes. They are essential to capture the dynamics of monetary transmission. A high positive value signifies that monetary policy significantly effects real economy and inflation. However, the extant literature assumes these parameters as time-invariant stating that these coefficients arise from micro-based models (Baele et al., 2009). Based on Campbell and Cochrane's (1995) external-habit model, the parameter φ captures the counteracting consumption-smoothing and precautionary-savings effects of risk aversion due to changes in macro-state variables. Baele et al. (2009) define ρ as the smoothing factor, which accounts for the Taylor rule of expected influences due to changes in monetary policy. Drawing on Boivin and Giannoni (2006), Baele et al. (2009) define the parameter S_t^{mp} as an estimate that accounts for the transition values of a Markov-chain process.

Yet, over the years researchers have used various other methods to account for SB return correlation. One of such methods that has received wide acceptance relates to affine asset pricing models (d'Addona and Kind, 2006), which I discuss next.

5.3.3 Affine Asset Pricing Models

The fair price of a financial asset is calculated as the product of expected future pay-offs and the pricing kernel, which is the stochastic discount factor. This ensures that there are no arbitrage opportunities in the economy. In discrete form it can be written as:

$$P_t^* = E_t[C_{t+1}^*, K_{t+1}^*] \quad (5-13)$$

where C represents the future expected cash flows and D represents the stochastic discount factor. The asterisk sign represents that the variables in the equation are considered as nominal rather than real. Drawing on Harrison and Kreps (1979), Campbell et al. (1997) derived the conditional logarithmic form of kernel. The general form is represented as:

$$-k_{t+1}^* = \delta + r_t^* + \varepsilon_{t+1}^{m*} \quad (5-14)$$

where $\varepsilon_{t+1}^{m*} \sim N(0, \sigma_k^2)$ stands for *i.i.d.* nominal pricing shocks, $\delta = \frac{1}{2}\sigma_k^2$ and r_t^* represents the nominal risk-free interest rate. Vasicek's (1977) model captures the mean-reverting nature of real short rate in discrete time. Considering \bar{r} and σ_r are the conditional mean and volatility respectively, the equation can be represented as:

$$r_{t+1} = \bar{r} + \alpha_r(r_t - \bar{r}) + \sigma_r \varepsilon_{t+1}^r \quad (5-15)$$

where $\varepsilon_{t+1}^r \sim N(0, \sigma_k^2)$ is an *i.i.d.* Similarly, an analogous process for inflation rate is:

$$i_{t+1} = \bar{i} + \alpha_i(i_t - \bar{i}) + \sigma_i \varepsilon_{t+1}^i \quad (5-16)$$

Based on (5-15) and (5-16), the interaction between real interest rate and inflation is derived as:

$$\sigma_i \varepsilon_{t+1}^i = \rho_{i,r} \sigma_r \varepsilon_{t+1}^r + \sigma_\phi \varepsilon_{t+1}^\phi \quad (5-17)$$

where $\rho_{i,r}$ captures the co-movement between real interest rate and inflation and $\varepsilon_{t+1}^\phi \sim N(0,1)$, *i.i.d.* represents the inflation uncertainty orthogonal to r_t .

Campbell et al. (1997) extend the standard affine model by introducing $\rho_{i,r}$. Further d'Addona and Kind (2006) allows inflation to be correlated with stochastic interest rate to price inflation risk. Under this new correlation structure the pricing kernel is represented as:

$$\varepsilon_{t+1}^{m*} = \beta_{m,r} \sigma_r \varepsilon_{t+1}^r + \beta_{m,i} \sigma_i \varepsilon_{t+1}^i + \sigma_\phi \varepsilon_{t+1}^\phi \quad (5-18)$$

where β estimates the shocks between the discount rate, interest and inflation. The error term $\varepsilon_{t+1}^o \sim N(0,1), i.i.d.$ represents the orthogonal fluctuations of the pricing kernel and the exogenous variables. Since, the error term only affects the mean rather than the slope of term structure, d'Addona and Kind (2006) derive the logarithmic pricing kernel as:

$$m_{t+1}^* = -\delta - r_t^* - \beta_{m,r} \sigma_r \varepsilon_{t+1}^r - \beta_{m,i} \sigma_i \varepsilon_{t+1}^i \quad (5-19)$$

For a bond with maturity n , the fair value is determined by the variables interest rate and inflation, which affects the nominal discount rate. The affine price model for a bond at time t can be represented as:

$$-B_t^{n*} = X_n + Y_n r_t + Z_n i_t \quad (5-20)$$

Based on the roots of (5-20), which follow a recursive form (d'Addona and Kind, 2006), the unit period logarithmic bond return is:

$$BR_{t+1}^{n-1*} = -X_{n-1} - Y_{n-1} r_{t+1} - Z_{n-1} i_{t+1} + X_n + Y_n r_t + Z_n i_t \quad (5-21)$$

In contrast to bonds, stocks do not have a pre-determined cash-flow stream. It can be derived as a present value of infinite stream of expected dividend pay-offs.

$$S_t = E_t[S_{t+1} \exp(d_{t+1}), K_{t+1}] \quad (5-22)$$

Considering D_t as the real dividend at time t , the dividend yield is $d_t = \ln\left(1 + \frac{D_t}{S_t}\right)$.

Drawing on Campbell and Shiller (1988) and Lewellen (2004), d_t is modelled as a mean-reverting stochastic process.

$$d_{t+1} = \bar{d} + \alpha_d (d_t - \bar{d}) + \sigma_d \varepsilon_{t+1}^d \quad (5-23)$$

d'Addona and Kind (2006) account for the interaction of interest rate and dividend yield, i.e.

$$\sigma_d \varepsilon_{t+1}^d = \beta_d \sigma_r \varepsilon_{t+1}^r + \sigma_\eta \varepsilon_{t+1}^\eta \quad (5-24)$$

where β_d represents the interaction term between interest rate and dividend yield and ε_{t+1}^η is the orthogonal error term.

The affine-pricing model for stocks determined by the state variable interest rate can be formulated as:

$$S_t = \lim_{n \rightarrow \infty} (X_n + Y_n r_t + Z_n d_t) \quad (5-25)$$

Unlike fixed income securities which have a finite maturity period, the roots of the affine-model for stocks follow an infinite recursive process. Including realised inflation, the logarithmic stock return for a unit period can be defined as:

$$SR_{t+1}^* = X_{n-1} - X_n + Y(r_{t+1} - r_t) + Z(d_{t+1} - d_t) + d_{t+1} + i_{t+1} \quad (5-26)$$

Equation (5-26) models stock returns as a function of the dividend-yield process. In similar studies Bekaert et al. (2000) model the equity returns based on dividend growth. Their equation accommodates the price-dividend ratio. The studies show that modelling in terms of dividend yield allows capturing the influence of uncertainty in interest rate and dividend-yield risk on stock premium.

5.3.4 SB Return Correlation in Affine Pricing Model

The theoretical expression for SB return correlation is obtained by employing the expectation properties of linear functions to equations (5-21) and (5-26). The correlation equation obtained is:

$$\rho_{sb} = \frac{-Y^s F \sigma_r - G \sigma_i - \beta_i \sigma_r^2 (Y_{n-1}^b + Y^s Z_{n-1}^b) - Y_{n-1}^b H - \beta_i Z_{n-1}^b H}{\sqrt{F^2 + G^2 + 2FZ_{n-1}^b \beta_i \sigma_r} \sqrt{Y^{s^2} \sigma_r^2 + \sigma_i^2 + (1 + Z^s) \sigma_d^2 + 2Y^s H + 2\beta_i (Y^s \sigma_r^2 + H)}} \quad (5-27)$$

where $F = Y_{n-1}^b \sigma_r$, $G = Z_{n-1}^b \sigma_i$ and $H = (1 + Z^s) \beta_d \sigma_r^2$.

Equation (5-27) reveals that the means of the three state variables, \bar{r} , \bar{i} and \bar{d} , do not have any impact on the SB return correlation, ρ_{sb} . Therefore, it is important to have a deeper insight of the factors influencing the SB return co-movements.

5.4 Alternative Approaches to Modelling Co-variances

Multivariate GARCH models have been widely employed by authors to model time-varying co-movements. Among them the most commonly used ones are Bollerslev et al.'s (1988) VEC model, Bollerslev's (1990) constant correlation model (CCM), Engle et al.'s (1990) factor auto-regressive conditional heteroskedastic (FARCH) model and Engle and Kroner's (1995) BEKK model. To review these models, I adopt the following notations: R_{it} is the rate of return of an asset i at time t , μ_{it} is the expected rate of return of the asset under the information set at time $(t-1)$, e_{it} is the unexpected return of the asset at time t , v_{it} is the conditional variance of R_{it} under the information set at time $(t-1)$, v_{ijt} is the conditional covariance of asset return i and j under the information set at time $(t-1)$ and V_t is the conditional covariance matrix ($V_t = [v_{ijt}]$).

5.4.1 The VEC Model

The VEC model is represented as:

$$v_{ijt} = \alpha_{ij} + \beta_{ij} v_{ijt-1} + \gamma_{ij} e_{it-1} e_{jt-1} \quad (5-28)$$

where $\alpha_{ij}, \beta_{ij}, \gamma_{ij}$ are parameters for all $i, j = 1, \dots, N$. The VEC model is an autoregressive moving average (ARMA) model for the unexpected asset returns. Thus, the key advantage of this model lies in its simplicity to estimate the conditional asset covariance. Considering the coefficient of the conditional lag variance to lie between zero and one, i.e. $\beta_{ij} \in (0,1)$ for all assets, Equation (5-28) can be estimated as

$$v_{ijt} = \varphi_t + \gamma_{ij} \sum_{\tau=1, t}^{\tau-1} \beta_{ij}^{\tau-1} e_{it-1} e_{jt-1} \quad (5-29)$$

where $\varphi_t = \beta^t v_0 + \alpha_{ij} \varphi_{t=0, t-1} \beta_{ij}^t$. This adjustment term ensures that the expectations of v_{ij} is the conditional asset covariance. Therefore, the model estimates the asset return co-movements as the geometrically weighted average of the past co-variances of expected returns. It gives lower weights to older observations.

The VEC model undermines two practical limitations. First, the number of parameters it generates is exceptionally large. For example, for a 10 (N)-asset model it generates

$\frac{3}{2}N(N+1)$, i.e. 165 parameters. Second, the model only gives a definite covariance matrix if restrictions are imposed to the weights of the older observations (Engle and Kroner, 1995). Without these nonlinear restrictions, the off-diagonal terms take values that are too large relative to the diagonal variances which force the VEC model to yield non-positive definite covariance estimates. This issue is overcome by the BEKK model, which I illustrate next.

5.4.2 The BEKK Model

The BEKK model is characterised as

$$V_t = \Omega + B'V_{t-1}B + A'e_{t-1}e_{t-1}'A \quad (5-30)$$

where Ω, A, B are $N \times N$ matrix. The matrix Ω represents the positive-definite symmetric covariance estimate. In terms of asset covariances BEKK can be written as

$$v_{ijt} = \alpha_{ij} + \text{cov}_{t-1}(e_{it}, e_{jt}) + (e_{pt-1}, e_{qt-1}) \quad (5-31)$$

where e_p, e_q, e_r, e_s are the unexpected returns of the portfolios p, q, r, s and α_{ij} is the ij th element of the positive-definite matrix. The portfolios p and q derive their weights from the ij th columns of matrix A and the weights of r and s comes from the matrix B . If Equation (5-31) is restricted to $B = kA$, where k is a scalar constant, then the model estimates conditional covariance for N -portfolios or assets.

While this model overcomes the positive-definite covariance limitation of the VEC model, it still estimates $(\frac{5}{2}N^2 + \frac{N}{2})$ parameters that restrict its practical usability. The FARCH model overcomes this issue of large scale estimation, which I discuss next.

5.4.3 The FARCH Model

The model is represented as

$$V_t = \Omega + \lambda\lambda'[\beta\delta V_{t-1}\delta + \gamma(\delta'e_{t-1})^2] \quad (5-32)$$

where β, γ are scalars, λ, δ are $(N \times 1)$ vectors and Ω represents the positive-definite symmetric covariance $N \times N$ matrix. The FARCH model is a special case of the BEKK

model. In particular the latter becomes FARCH when $A = \sqrt{\gamma}\delta\lambda'$ and $B = \sqrt{\beta}\delta\lambda'$. The number of parameters estimated by this model $\left(\frac{1}{2}N^2 + \frac{5}{2}N + 2\right)$ is considerably less than the VECH and BEKK models.

Using conditional covariance and unexpected return of the assets/portfolios, the FARCH model can be characterised as

$$v_{ijt} = \alpha_{ij} + \lambda_i \lambda_j v_{pt} \quad (5-33)$$

$$v_{pt} = \alpha_p + \beta V_{pt-1} + \gamma e_{pt-1}^2 \quad (5-34)$$

where $R_{pt} = \delta'R_t$, $v_{pt} = \delta'V_t\delta$, $e_{pt-1} = \delta'e_{t-1}$ and $\alpha_p = \delta'\Omega\delta$, $\sigma_{ij} = \Omega_{ij} - \lambda_i \lambda_j \alpha_p$

The FARCH model assumes that the assets' variances and co-variances contribute to the variance of a single portfolio, which follows a GARCH process. In case on a single factor model, the market return is considered to be R_{pt} . Thus, for a single factor model the variance-covariance asset return matrix is driven by the market portfolio.

The number of factors (N) that drive the conditional matrix Ω differentiates the use of the FARCH and the BEKK model. If there are multiple factors we use the BEKK model, whereas for a unit factor we use the single factor FARCH model.

5.4.4 The Constant Correlation Model

In this model the conditional correlation of the asset returns are assumed as time-invariant. The restriction on the conditional variance is weighted proportional to the asset risk. The CCM is represented as

$$v_{iit} = \alpha_{ii} + \beta_{ii} v_{iit-1} + \gamma_{ii} e_{it-1}^2 \quad (5-35)$$

$$v_{ijt} = \rho_{ij} \left(\sqrt{v_{iit}} \sqrt{v_{jjt}} \right) \quad (5-36)$$

Equation (5-35) is for all $i = 1, \dots, N$ and Equation (5-36) is for all $i \neq j$. Yet, CCM yield positive definite estimate only if the correlation matrix $[\rho_{ij}]$ is non-negative and definite.

5.5 Properties of the GARCH Models

The four models discussed above belong to the family of multivariate GARCH models. Each of them imposes a different set of restrictions to estimate the variance-covariance processes of the asset/portfolio returns. To analyze the properties of each of the four models, I rely on Kroner and Ng 's (1998) estimations of portfolio returns on small and big firms. The data consists of 1371 weekly observations from July 1962 to December 1988 for US market. The mean return is modelled using a 10-lag VAR process, which is characterised as

$$R_{it} = \Delta_{i0} + \sum_{j=1,2} \sum_{\tau=1,10} [\Delta_{j\tau} R_{jt-\tau} + d_{jt} \max(-R_{jt-\tau}, 0)] + e_{it} \quad (5-37)$$

where i takes the value '1' and '2' for small firms and large firms-portfolio respectively. The q0-lag threshold terms ensure that the variance-covariance asymmetric effects do not impose misspecification in the estimation of the mean.

Table 5-1 shows the summary statistics of the different variance and covariance estimates of the four different MGARCH models.

Table 5-1: Estimated Variance and Covariance Series ^a

Model	Variable	Mean	SD	Minimum	Maximum
Small-firm variance					
	ε_{1t}^2	7.43	28.97	0.00	825.45
VECH	h_{11t}	7.73	6.31	3.82	104.98
CCORR	h_{11t}	7.91	7.08	3.54	117.60
FARCH	h_{11t}	7.51	4.14	2.87	33.24
BEKK	h_{11t}	7.53	4.91	2.64	50.67
Large-firm variance					
	ε_{2t}^2	3.93	8.12	0.00	147.87
VECH	h_{22t}	3.89	2.58	1.10	21.53
CCORR	h_{22t}	3.96	2.78	0.98	23.49
FARCH	h_{22t}	4.12	3.18	0.74	27.08
BEKK	h_{22t}	4.16	3.20	0.76	26.15
Covariance					
	$\varepsilon_{1t}\varepsilon_{2t}$	2.61	8.59	-45.44	167.55
VECH	h_{12t}	2.33	1.49	0.30	17.59
CCORR	h_{12t}	2.47	1.48	0.91	15.60
FARCH	h_{12t}	2.79	2.42	0.30	21.71
BEKK	h_{12t}	2.77	2.66	0.25	30.71

The table reports the summary statistics of the four GARCH models. The results are computed on the same data set. 'e' denotes the unexpected return shocks and 'h' denotes the estimated variance-covariance of the portfolios.

^a Source: Adopted from Kroner and Ng (1998)

It is evident that the co-variance estimates of FARCH and BEKK models are higher and more volatile than the VECH and constant correlation (CCORR) model. In particular the BEKK models produce a greater range of estimates as compared to the remainder. Focusing on variance estimates, the volatility of FARCH and BEKK model estimates are higher for large-firms in contrast to the high volatility estimates of VECH and CCOR models for small firms.

In order to further justify my claims that the different models generate a different and varied range of estimates, I report the correlation of these covariance and variance estimate in Table 5-2.

Table 5-2: Correlation of MGARCH Model Estimates ^a**Panel 1: Small-firm portfolio variance series**

	VECH	CCORR	FARCH	BEKK
VECH	1.000			
CCORR	0.999	1.000		
FARCH	0.367	0.365	1.000	
BEKK	0.642	0.640	0.834	1.000

Panel 2: Large-firm portfolio variance series

	VECH	CCORR	FARCH	BEKK
VECH	1.000			
CCORR	0.999	1.000		
FARCH	0.999	0.999	1.000	
BEKK	0.954	0.954	0.955	1.000

Panel 3: Covariance series

	VECH	CCORR	FARCH	BEKK
VECH	1.000			
CCORR	0.876	1.000		
FARCH	0.748	0.785	1.000	
BEKK	0.752	0.719	0.885	1.000

The small firm correlation of variance estimates are presented in panel-1, the large firm correlation of variance estimates are presented in panel-2 and panel-3 reports the correlation of the covariance estimates.

^a Source: Adopted from Kroner and Ng (1998)

The correlations of the variance of large-firm estimates in panel-2 exceed 0.999. This suggests that all models yield similar results; hence model selection is relatively unimportant. Yet, similar conclusions do not hold well for panel two and three. Judging from these findings, it is pertinent that model selection plays a vital role in estimating covariance of asset/portfolio returns. Consequently, the selection of models will invariably affect asset pricing, estimation of asset return correlation and portfolio management applications. Drawing on this conclusion, in my next section I illustrate the avenues of future research.

6 Empirical Analysis

In this section I examine the link between SB return correlation and economic state variables. In particular, I investigate this association for the U.S. capital market for the period 1991 to 2011. Drawing on this analysis and on the overall review of the existing literature (cf. Section 5), I provide an account for future avenues of research. The primary purpose of this examination is to make robust claims related to the extant literature. Further, the empirical findings considerably aid in i) analyzing potential research gaps and in ii) proposing future areas of research, as elaborated in the following sections.

6.1 Data and Methodology

The empirical analysis examines quarterly data of U.S. SB returns. The U.S. market is considered for the analysis because i) it represents the largest financial market in the world and ii) it is generally viewed as the most important economy. The sample period spans from January 1991 to December 2011. Table 6-1 reports the description of control variables and data used for the empirical analysis.

Table 6-1: Description of Variables

Variable Category	Variable	Data Source
Endogenous Variable (constructed from)	Daily MSCI Stock Market Returns	DataStream
	Government Bond Indices (10 years)	
Exogenous Variables:	GDP, RI and ExpInf	DataStream
Economic output (GDP)	Real Gross Domestic Product absolute values	
Real Interest (RI)	Difference between annualized 3-month Treasury Bill middle rate annualized returns converted to quarterly returns $((\ln(1+R))/4)$ and short-term expected inflation	
Expected Inflation (ExpInf)	One month forecast of monthly inflation, the Industry Production growth rate and T-bill rate, employing a Bayesian Vector Auto-regression model.	

To examine the impact of macroeconomic state variables on SB return correlation, I formulate Equation (6-2). A potential challenge in regressing is that the correlation coefficient varies from positive one to negative one, i.e. [+1 to -1]. In contrast, the right hand side of the equation is unrestricted, thus to make the endogenous variable

unrestricted, I employ Fisher's transformation using Equation (6-1). This transforms the correlation coefficient values from $[-1, 1]$ to $(-\infty, \infty)$.

$$Corr = \frac{1}{2} \ln \left(\frac{1 + \rho}{1 - \rho} \right) \quad (6-1)$$

$$Corr_t = \beta_0 + \beta_1 GDP_{t-1} + \beta_2 RI_{t-1} + \beta_3 ExpInf_{t-1} + \beta_4 T_{Corr_{t-1}} + \varepsilon_t \quad (6-2)$$

where ρ is SB return correlation, GDP is the economic output, RI is the real interest rate, $ExpInf$ is the expected inflation.

6.2 Results

The descriptive statistics of the SB return correlation are reported in Table 6-2. The SB return correlation estimate for the period observes a negative mean of 0.032. The overall range of the estimate varies from negative 1.045 to 1.038.

Table 6-2: Descriptive Statistics of SB Return Correlation

	Mean	Median	Std. Dev.	Kurtosis	Skewness	Minimum	Maximum
Corr.	-0.032	-0.006	0.490	-0.779	-0.059	-1.045	1.038

The quarterly rolling correlation is plotted in Figure 6-1. Although the correlation is negative on average, it is apparent that the time-varying relationship of SB returns is unstable and has observed sustained variations over time. Moreover, the figures reveal that the co-movement can vary substantially over a short-period of time. For example, in the year 1997 the correlation changed from 0.48 to negative 0.16 for the period October – November. These unexpected changes in the correlation impose challenges for risk management measures and asset allocation. Thus, commonly employed risk monitoring techniques that assume time-invariant SB return correlation will yield spurious results and may adversely affect investment strategies. For U.S. the co-movement remained positive until November 1997. After that it dipped below the neutral mark and hovered in the negative region until 2011. Yet, for a short period, i.e. March 1999 to June 2000, the correlation yielded a positive return. This can be attributed to the excessive economic growth during this period.

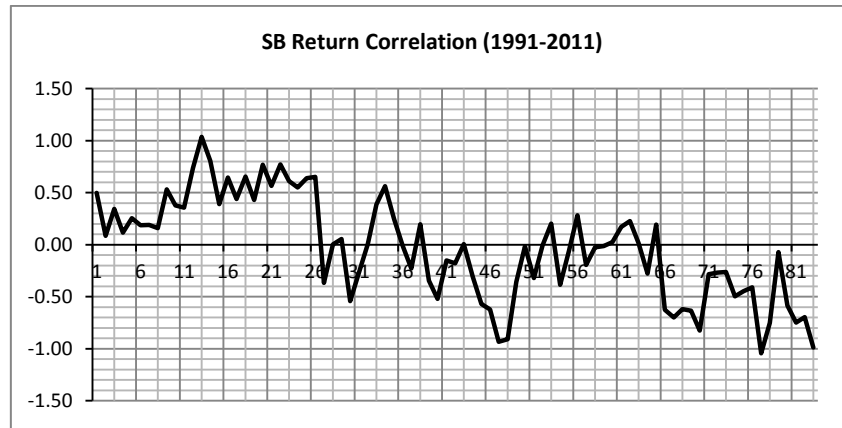


Figure 6-1: Dynamic SB Return Correlation

To ascertain that the exogenous variables do not yield spurious results, Table 6-3 reports the augment Dickey-Fuller test results. The lag length is based on Schwartz information criteria. The results of the unit root test reveal that the explanatory variables are stationary.

Table 6-3: Unit Root Tests ^a

GDP t-1: ADF tests (T=79, Constant; 5%=-2.90 1%=-3.51)							
D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
2	-3.813**	0.54565	0.005688	1.462	0.1479	-10.29	
1	-3.496*	0.61141	0.005731	-1.860	0.0668	-10.29	0.1479
0	-5.009**	0.50889	0.005821			-10.27	0.0657
Expinf: ADF tests (T=79, Constant; 5%=-2.90 1%=-3.51)							
D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
2	-2.445	0.87639	0.004970	-1.155	0.2516	-10.56	
1	-2.649	0.86742	0.004981	0.6244	0.5342	-10.57	0.2516
0	-2.586	0.87368	0.004961			-10.59	0.4260
RI t-1: ADF tests (T=79, Constant; 5%=-2.90 1%=-3.51)							
D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
2	0.07814	1.0034	0.2273	0.9731	0.3336	-2.914	
1	0.3600	1.0151	0.2272	2.235	0.0283	-2.926	0.3336
0	1.476	1.0568	0.2330			-2.888	0.0574

^a A Dickey-Fuller test is conducted to test for the presence of unit root – the time series is non-stationary. The series is defined as: $DY_t = dY_{t-1} + \mu_t$, where DY_t is the first difference operator of the series and μ_t is the white noise $\mu_t \sim N(0,1)$. The null hypothesis (H_0) is $d=0$, that there exists a unit root. * and ** denotes significance at 0.1 and 0.05 at 0.01 percent levels.

The regression results of the dynamic model are reported in Table 6-4. The estimation results reveal that expected inflation is positively related to the SB return correlation. Arguing that bond prices are negatively related to expected inflation, my findings confirm that higher inflation expectations have a greater impact on discount rates than on expected equity dividends. This causes inflation to vary negatively with stock prices and thereby poses a positive relation with SB return co-movements. The result also demonstrates a trend in the time-varying phenomenon with a positive coefficient of a single period SB return correlation lag. Finally, it can be noted that the estimated coefficients of expected economic output, i.e. GDP and real interest rate, are statistically not significant (cf. ^a * and ** denotes significance at 0.1 and 0.05 at 0.01 percent levels Table 6-5).

Table 6-4: Impact of Macroeconomic Variables on SB Return Correlation ^a

	Coefficient	Std.Error	t-value	t-prob	Part.R ²
Corr_1	0.422784	0.1262	3.35	0.002	0.1929
Constant	-0.270721	0.6199	-0.437	0.664	0.0040
GDP t-1	9.05269	8.077	1.12	0.268	0.0260
RI t-1	-0.0206099	0.1290	-0.160	0.874	0.0005
Expinf	15.5352	4.663	3.33	0.002	0.1910
sigma	0.27693	RSS		3.6044421	
R ²	0.675129	F(4, 47) =	24.42	[0.000]**	
log-likelihood	-4.38881	DW		1.8	
no. of observations	52	no. of parameters		5	
mean(Corr)	0.13163	var(Corr)		0.213366	

^a * and ** denotes significance at 0.1 and 0.05 at 0.01 percent levels

Table 6-5: Test of Significance of Explanatory Variables ^a

Tests on the significance of each variable				
Variable	F-test	Value	[Prob]	Unit-root t-test
Corr	F(1, 47) =	11.230	[0.0016]**	-4.5752**
Constant	F(1, 47) =	0.19072	[0.6643]	
GDP t-1	F(1, 47) =	1.2562	[0.2681]	1.1208
RI t-1	F(1, 47) =	0.025522	[0.8738]	-0.15976
Expinf	F(1, 47) =	11.098	[0.0017]**	3.3314

^a * and ** denotes significance at 0.1 and 0.05 at 0.01 percent levels

Figure 6-2 plots the fitted value of the dynamic model in relation to the observed correlation values.

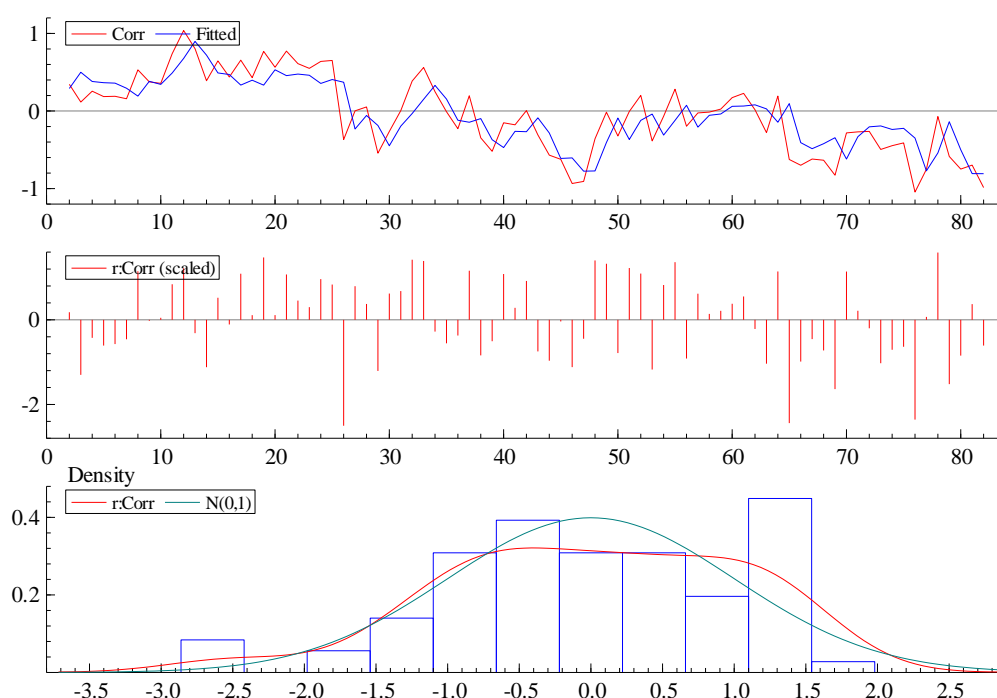


Figure 6-2: Fitted Value of SB Return Variance ^a

^a Test for error autocorrelation: $\chi^2(80) = 105.91$ [0.0279]*. We reject presence of autocorrelation at 10% significance level. Test for heteroskedasticity using squares: $\chi^2(340) = 321.53$ [0.7567]*. We reject presence of heteroskedasticity at 10% significance level.

The findings, therefore state that uncertainty of expected inflation plays a dominant role in defining SB return co-movements. Yet, the impact of other economic state variables such as changes in expected output and interest rate play a minor role in determining the time-varying correlation of SB returns. This illustrates that factor models primarily fail in fitting covariances. It confirms several studies, including Baele et al. (2009), Bekaert and Engstrom (2010), Downing et al. (2009) amongst many other as discussed in the previous section. Therefore, it brings to concern the necessity to examine this phenomenon by considering factors other than generic economic state variables, which I next elaborate in details.

6.3 Discussion and Scope for Future Research

Existing research on SB return co-movements considers a large number of fundamental factors to account for the dynamic correlation. These factors include pure economic state variables and factors that account for risk aversion and illiquidity. Authors also employ a large number of model specifications and some using structural restrictions.

Interestingly, the performance of the models improves for New-Keynesian models when the factor shocks and the structural breaks are indentified. But, overall these models fail to find a significant fit and forecast realised correlations for SB return co-movements (Baele et al., 2009). The majority of these dynamic models use daily return data and are backward-feeding. They fit the data well but fail to generate realised co-movements. Some authors generate positive correlation until 1980 and negative thereafter, yet their assumption of constant factor exposure fails to mirror the observed data pattern. Such studies include Baele et al. (2009), Bekaert et al. (2009; 2010) and Cochrane (1991). When the factor exposures are considered as functions of the variance premium, the models correlates with the realised data. Yet, the magnitude and the time significantly differ from the actual (Baele et al., 2009).

The analysis of my findings in the previous section reveals a wide range of promising directions for future research, which address the research gaps in the current literature. First, arguing that stocks are excessively volatile, the model fit is poor as authors fail to account for actual stock implied volatility. Literature shows that the models fail to fit the co-variances (cf. Section 5.5, p. 42) and a deeper insight reveals that actual bond volatility fit is poorer than the stock volatility. Second, researchers fail to acknowledge that non-economic state variables such as illiquidity factors influence the SB return covariances more than the macroeconomic variables. Hence, much more scope lies in analysing the dynamic illiquidity effects. Third, there is an interesting debate concerning the volatility dynamics of stocks and bonds. While the bond volatility depends on economic state variables, the non-economic variables such as liquidity factors and variance premiums drive the stock volatility more significantly. These differences create complications in building an equilibrium model, which can jointly account for stock and bond pricing. Studies in this area have failed to account for a significant equilibrium model (Bekaert et al., 2009). Forth, even though researchers in the past have exclusively focused on standard economic variables, more intricate models would likely yield superior results. These models may probably incorporate variables that have been neglected in the present literature. For example, financial integration might have fundamentally impacted the asset pricing mechanism, even of developed economics like the U.S. Another example, relates to the emerging economies where the heterogeneity of wealth and income may have a significant influence on the

overall asset pricing. Fifth, none of the models in the extant literature provide satisfactory fit for ‘flight-to-safety’ phenomenon, which can be viewed as a primary reason for negative SB return correlation (Baele et al., 2009). Finally, the majority of the studies relate to developed economies and far less research has been done concerning the emerging economies. This allows a wide scope of research in analysing the issues related to global financial integration. Furthermore, high-frequency data can be used to examine the influence of private information, public information and contagion on market dynamics.

Importantly, we have seen that SB return co-movement has been an area of interest for a long time. Without a proper assessment of the characteristics of the time-varying phenomena generated by the models, judgements remain inconclusive and premature. For instance, the literature has made many claims about the negative SB return correlation for the years. Yet, in recent times the real economy and inflation processes in developed and emerging economies have witnessed substantial changes. In particular, the volatility of these two macroeconomic variables has decreased significantly in the U.S. and other developed economies since 1985 (Baele et al., 2009). Consequently, if stocks and bonds have alike exposure to these economic state variables, their return correlation should also decrease. It is equally pertinent that changes in these fundamental variables have affected the risk aversion, which affects stocks and bonds in dissimilar ways. While extant literature shows that it is difficult to figure out economic state variables that cause a steep decline in SB return correlation, it remains worthy to quantify the magnitude of the influence of these economic variables on the time-varying dynamics of SB return correlation. This is what I aim to establish in my doctoral thesis employing a dynamic factor model.

In Appendix-C, I graphically illustrate the research gaps in the existing literature by mapping the main arguments of the key authors.

7 Conclusion

My review of the existing literature has illustrated the importance of SB return correlation which has not been fully demystified and far less fully operationalised. These findings contribute in different ways to advancing the knowledge around my tentative research questions. Several authors have tried to establish the phenomenon of time-varying SB return comovements based on the analysis of empirical findings. Yet, the key contributors restrict themselves to the total risk witnessed by the market rather than considering idiosyncratic risk and systematic risk separately. Therefore, it is necessary to explore the constructs and underlying principles that build this time-varying correlation and its effect on portfolio selection and optimisation (cf. Figure 7-1). Furthermore, the extant literature is still unsettled regarding the effect of inflation volatility on SB co-movements (Yang et al., 2009). Thus, the debate on how SB correlation varies to changing macroeconomic conditions, especially in lower frequencies, is open to further research and analysis as stated in the previous section.

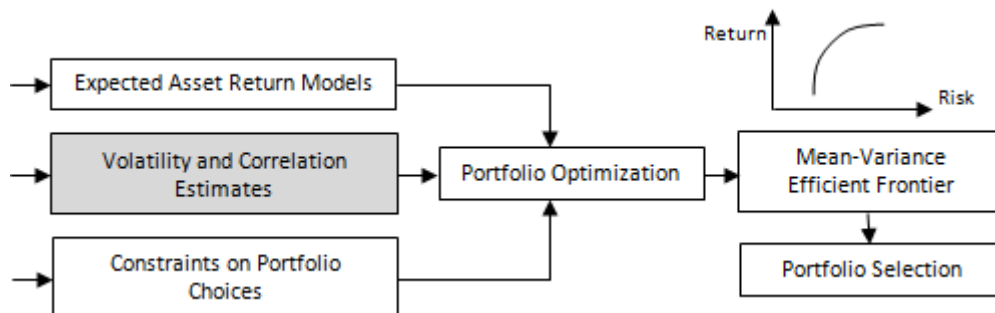


Figure 7-1: The Investment Process

7.1 Illustration of Economic Importance

Accurate estimation of SB return covariance is critical for portfolio optimisation and risk management. To elaborate on this I throw light on two different problems, which brings to concern the importance of asset, i.e. SB, return covariance estimates.

First, I consider the problem of calculating weights of the assets for a fully invested optimal portfolio subject to a no-short selling constraint. In order to avoid forecasting of asset returns, portfolio managers construct an equivalent scenario by estimating the

portfolio-weights subjected to portfolio-risk minimisation. Thus, the equivalent objective function is characterised as

$$w_{1t} = \frac{v_{22t} - v_{12t}}{v_{11t} - 2v_{12t} + v_{22t}} \quad (7-1)$$

where w_{1t} is the weight of a particular asset at time t and v_{22t} is the asset return covariance. In case of a fully invested portfolio the total weight of the combined assets is equal to one, i.e. $w_t = w_{1t} + w_{2t}$. Thus, Equation (7-1) states that the optimal portfolio decision relies on the accuracy of the asset correlation/co-variance matrix estimate.

Second, I consider the issue of estimating the optimal hedge ratio that minimises the portfolio risk. To illustrate, if a portfolio manager wants to minimise the risk of holding \$1 in stock-portfolio, he/she should have an investment of β in short position. The variable β is the ‘dynamic optimal hedge ratio’ which minimises the overall portfolio risk. β is characterised as

$$\beta_t = -\left(\frac{v_{12t}}{v_{22t}}\right) \quad (7-2)$$

Importantly, Equation (7-2) states that the process of portfolio risk minimization involves the estimation of the optimal hedge ratio, which is a function of the asset-return correlation, i.e. v_{22t} .

7.2 Contribution of this Review

This review has several distinct features. First, it is the only study to date that extensively reviews and critically examines the existing literature on SB return co-movements. Second, this study uniquely states the criteria for the selection of the journal articles for the review. This process meets the valid guidelines of conducting a systematic review (cf. Tranfield et al., 2003). Third, the review provides empirical evidence of the SB return co-movement for the U.S. capital market. It first reports the major trends in SB return correlation and then examines the phenomenon employing a dynamic model, which captures the asset return dynamics. The results confirm the existing literature, stating that the fluctuations in the co-movement are primarily

attributed to uncertainty of expected inflation. Further, decomposing the performance of the factor model, I provide a rich insight on the future theoretical modelling of SB return correlation. Drawing on this, the paper finally highlights specific features in the literature and points out several potential avenues for further research (cf. p. 49). Finally, I propose a copula function approach (CFA) to estimate the stochastic SB return co-movement.

7.2.1 An Alternative Approach

The concept of correlation is fundamental to financial theory. For instance, CAPM and APT use correlation to measure the extent of dependence between various investment instruments. Additionally, in financial economics, correlation is a measure to determine the relationship between occurrences of various economic events and state variables. As discussed in Section (5.4, p. 39), authors use various MGARCH models to estimate the covariance value. But, these model yield results which differ significantly from each other, driving the estimate to remain inconclusive. Further, it is evident that past return shocks have asymmetric effects on asset-return covariances, but the existing models from the extant literature fail to address these issues (Kroner and Ng, 1998). The conditional moment test results provide evidence of these limitations (cf. Appendix D). Yet, instead of building on existing models, I aim to use an alternative approach that will enable me to estimate a more precise value of the dynamic SB return covariance.

Considering an n -asset portfolio, I can use a historical approach to determine the marginal distribution of each asset risk. Assuming independent asset risks, any issue relating to the portfolio and its expected return can be easily analysed. However, the independence assumption is obviously not realistic. The risk of an asset class tends to be higher when the economy is in recession and vice versa. This implies that a same set of economic state variables influences the asset classes and there exists a risk-relationship among these financial instruments. The only way to construct a correlation of the asset-risks into the portfolio is to determine a joint distribution with given marginal distributions. There is no unique solution to this problem. I, therefore, aim to use a mathematical technique, i.e. CFA, which can potentially be applied for correlation modelling and forecasting to attain higher precision.

7.2.2 Copula Function Approach

Mathematically, a copula function allows us to construct a joint distribution with a specific dependence structure by combining univariate distributions. For m random variable, U_1, U_2, \dots, U_m , the joint distribution Copula function C is defined as:

$$C(u_1, u_2, \dots, u_m, \rho) = \Pr[U_1 \leq u_1, U_2 \leq u_2, \dots, U_m \leq u_m] \quad (7-3)$$

Therefore, from a given univariate marginal distribution function $F_1(x_1), F_2(x_2), \dots, F_m(x_m)$ the resultant copula function is characterised as

$$\begin{aligned} C(F_1(x_1), F_2(x_2), \dots, F_m(x_m), \rho) &= \Pr[U_1 \leq F_1(x_1), U_2 \leq F_2(x_2), \dots, U_m \leq F_m(x_m)] \\ &= \Pr[F_1^{-1}(U_1) \leq x_1, F_2^{-1}(U_2) \leq x_2, \dots, F_m^{-1}(U_m) \leq x_m] \\ &= \Pr[X_1 \leq x_1, X_2 \leq x_2, \dots, X_m \leq x_m] \\ &= F(x_1, x_2, \dots, x_m) \end{aligned} \quad (7-4)$$

Skylar's (1959) theorem states that if X and Y are marginals, then the copula function can be equated as

$$C(u, v) = F_{xy}(F_x^{-1}(u), F_y^{-1}(v)) \quad (7-5)$$

The choice of my copula functions will be driven by the modelling requirements. The most commonly used functions are (i) the Gumbel copula for extreme distributions, (ii) the Gaussian copula for linear correlations and (iii) t-copula for tail dependency (Heffernan, 2000; Nelsen, 1998). Both the Gaussian copula and t copula are derived from multivariate normal distributions. Yet, in the latter tail-dependency can be set by varying the degrees of freedom. The Gumbel copula is used when the tails of the marginal distributions from the empirical results are abrupt and have to be fitted using extreme value theory related techniques, such as the Gumbel distribution.

From a practitioner's perspective the ability to condition a copula to fit all the data seems to be a very powerful tool. It is equivalent to fitting non-linear regressions. It has its benefits over traditional Markov chains in generating expected distribution given a variable value. Research states that by conditioning copulas of different forms with

varying tail, dependencies can be modelled together in one model (Bouyé et al., 2000). Thus, considering the individual asset returns to reflect the *marginal* risks and the portfolio payoff as the *joint* risk, it becomes evident that solutions involving copulas are desirable. Figure 7-2 illustrates the use of CFA in calculating portfolio payoffs.

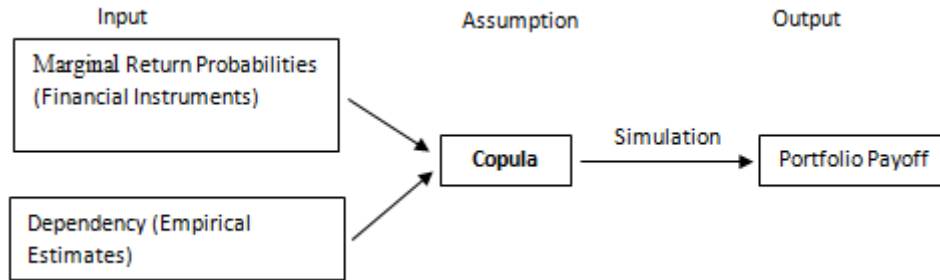


Figure 7-2: Estimating Portfolio Payoff using a Gaussian Copula

The observed marginal risk coupled with the correlations and the Gaussian copula (for instance) defines the joint risk distribution of the portfolio payoff. Portfolio payoff can then be estimated from the joint distribution by employing a Monte Carlo simulation. Drawing on this, I discuss next the implication of this study for my doctoral research.

7.3 Implications for my Doctoral Research

In this study, I deliberately include an empirical examination of the phenomenon under investigation. This allows me to strengthen my argument and state the potential research gaps concerning the extant literature on SB return co-movement. When modelling this phenomenon, researchers face a challenging trade-off between statistical precision and economic rigor. Some authors attempt to give a strong economic reasoning to the time-varying correlation employing simple equilibrium models, but their model fit with the realised data is far from perfect (d’Addona and Kind, 2006). Alternatively, current research focuses on developing complex models to justify the historic correlation of SB returns.

For my doctoral research, I aim to incorporate a sufficient level of actionable content (mathematical modelling and testing; cf. Section 7.2.1, p. 55) to reconcile time-varying stock-bond return covariance. To this end, I specify four boundaries, informed by the current literature that will characterise my future research.

i. Theoretical Boundary: the analysis of stock-bond returns correlation from an asset allocation perspective focuses on portfolio optimisation and examining the interactions of various economic and non-economic state variables.

ii. Disciplinary Boundary: considering the inter-disciplinary nature of my topic, studies will be drawn from social sciences (financial economics) and applied sciences (applied mathematics).

iii. Application Boundary: to all intents and purposes, applications are social constructions. To draw this more clearly I will formulate my constructs efficiently to be used for practical application such as portfolio optimisation, forecasting asset correlations and predicting asset returns, rather than constructing only conceptual models.

iv. Contextual Boundary: to explore the extent of financial integration across various financial markets, data pertaining to all developed markets and emerging economies will be considered.

Based on the foregoing analysis and my ongoing research, I propose possible areas of investigation. To begin with the defined scope, in my doctoral research I aim to ask whether the dynamic factor models that feeds in a number of economic state variables explain the average SB return variation over time.

Table 7-1: Dimensions of Research Enquiry

	Macroeconomic Variable	Asset Allocation and Portfolio Optimization
Developed and Emerging Economies	Sub Theme 1	Sub Theme 2
Modeling Techniques	Sub Theme 3	Sub Theme 4

Following this overarching question, I seek to investigate a number of sub-themes addressing the key issue. Table 7-1 illustrates the emergence of these four different areas of examination. The first area relates to the investigation of the impact of macroeconomic variables on SB return correlation in developed as well as emerging economies. The second area pertains to the analysis of how changes in the SB return dynamics effect portfolio management. Both these sub-themes address the effect of

financial integration on the time-varying dynamics of SB returns. The third area deals with the modelling issues of SB return co-movement. As discussed, I propose to apply a copula function approach to address this area of concern. Finally, the last sub-theme examines the modelling technique's robustness in relation to managerial applications.

7.4 Limitations

This review has three limitations. First, the review question reflects my biases and preferences as a researcher. This also relates to the structure of the review question, which assumes the effect of certain macroeconomic factors to influence SB return correlation. Although this is not a limitation in itself, it might have precluded the inclusion of articles outside this research area. Second, the majority of the studies are on developed economies. Consequently, this study provides insufficient empirical evidence on emerging economies. Yet, this contributes to areas for further empirical investigation. Third, the quality appraisal criteria are based on my personal critical judgement. Thus, it is subjective and might have been biased by my personal preferences. However, significant alterations and periodical checking and review has been conducted to avoid a major impact on the overall analysis of the existing literature.

In terms of analysis, the discussion primarily focuses on answering the review questions. This might have neglected certain other distinct features related to the literature. Yet, the study analyses all the critical dimensions related to the governing dynamics of SB return correlation, examining the research questions addressed, data used and methodology adopted.

Finally, the positivists research paradigm, which dominates social science research in finance poses certain limitations. The repressive nature of capital market research and the process in which it is disseminated lacks multidimensional perspectives. Furthermore, assumptions and ideologies of empirical financial research are based on unidimensional, neoclassical economic models. Thus, the deterministic view of quantitative financial research is similar to that of statistical mechanics. Alternatively, considering the issue from an interpretivist stance, the things are quite different. First, the appearance of certainty in measuring correctness of a theory is comforting, even though we neglect the disturbing ambiguity about objects that are neither correct nor false. In my case measuring the significance of a correlation coefficient suggests

underlying interdependence between SB returns, thus neglecting the influence of human interference in making financial investment decisions. Second, I consider the relationship between SB returns as a single dimensional universally identical object, strictly governed by laws. Yet, human beings contrive to define institutions and customs that govern social interactions. The rules of the society are thus not static and they change both undesirably and unlikely. In my view of quantitative research, researchers fail to distinguish themselves from this unpredictable pattern of human behaviour, assuming independent asset risks. The independence assumption is obviously not realistic. In sum, financial activities can be viewed as inelastic interactions between human beings. They tend to be more subjective which stands in contrast to the objective assumptions of the positivist paradigm, which underpins the limitations of the proposed research methods in the extant literature.

Personal Learning

In this section, I reflect upon my learning as a researcher while undertaking this study. First, I report my specific aspects of learning and then move on to my overall learning experience.

I firmly believe that conducting this systematic review was very beneficial for me. It enabled me to upgrade many of my research skills. It started with identifying my key articles and then the auxiliary ones. My area of interest is in the field of investment processes, which has been researched quite comprehensively. Thus, finding the most appropriate papers that specifically address and define the literature was a demanding task. I particularly enjoyed writing the discussion and the empirical analysis part, which examines and justifies the contributions of the existing literature. I had a clear review protocol for this study, which enabled me to conduct the literature review in an efficient and exhaustive manner.

Focusing on my writing experience, I tend to write as I read on. This helps me to get started with my work at the earliest. However, it is an iterative process, and it often requires revising what I have written to formulate a clear argument. For this study, I specifically maintained a workbook, which I updated as I read my articles. This allowed me to synthesise my thoughts in a more efficient way.

Overall, my learning during this study is a step function, even though it follows an increasing exponential trend (cf. Figure 7-3). Research for me is fun and I love doing it. I also believe that learning is a continuous self-enriching process, which only gets better with time.

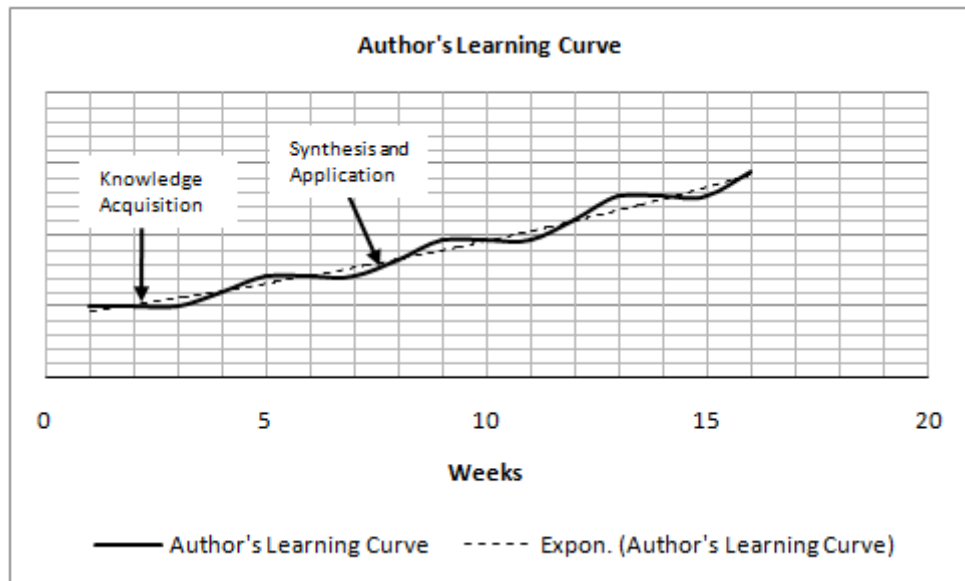


Figure 7-3: My Learning Curve

In general, this programme (MRes) has helped me to improve my ability to appreciate, understand and interpret research from different ontological and epistemological perspectives. My learning style inventory scores reveal my preference towards reflective observation and abstract conceptualisation (cf. Figure 7-4). It is not surprising for me to know that I am a convergent learner and an assimilator.

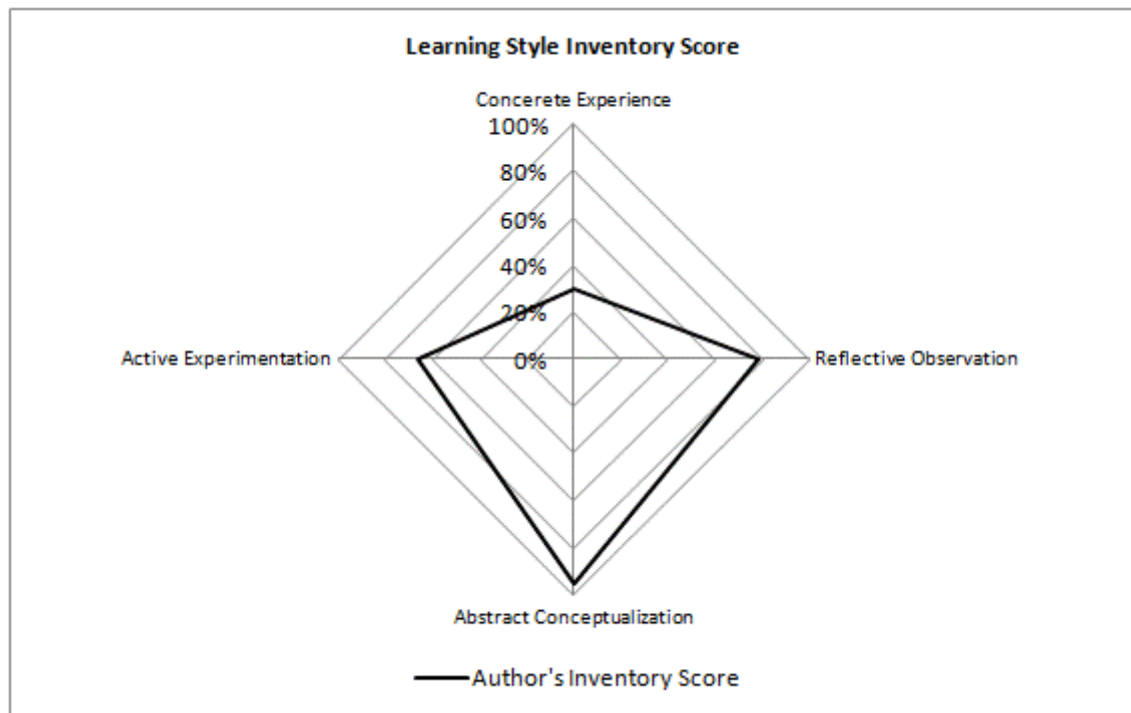


Figure 7-4: My Learning Style

Possibly having the traits of both a convergent learner and an assimilating thinker, I fall in the intersection of these two learning styles. I call this space as “design thinking”¹² (cf. Figure 7-5).

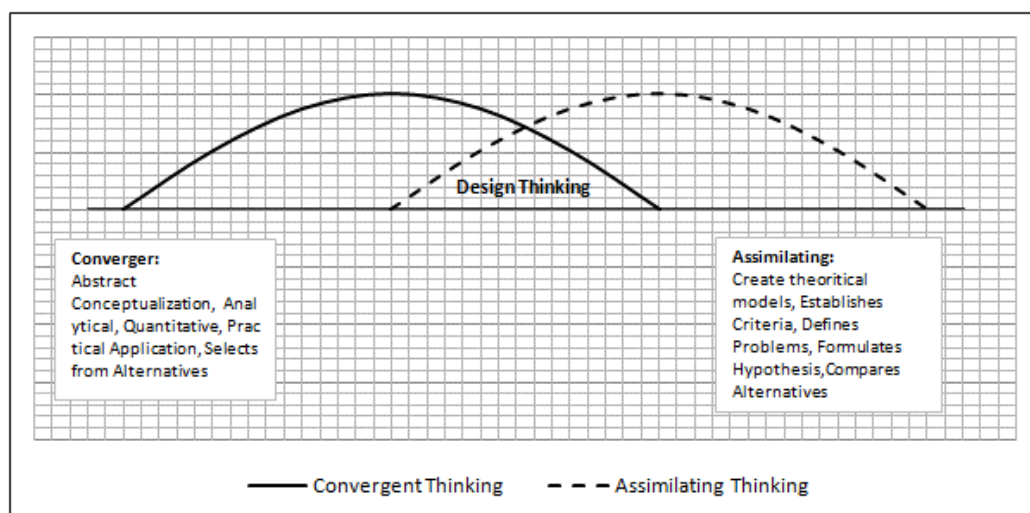


Figure 7-5: My Strengths

¹² “Design Thinking” refers to practical and creative solution to issues generating better results.

I enjoy defining problems, conceptualising theoretical models to address them, testing these models by applying mathematical techniques, playing with data sets and analysing their practical applicability. I consider myself as a beginner and hope to remain so as I understand that knowledge knows no boundaries.

Above all, I thank my supervisor for supporting me and clarifying my queries at every point of time. His guidance and feedback has always been my inspiration.

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Appendices

Appendix A: Data Extraction Forms

Ref. no. 1 (QAS: 112221)
Citation
Title: Why the does the correlation between stock and bonds vary over time?
Author(s): Andersson, M., Krylova, E., Vahamaa, S.
Journal / Source: Applied Financial Economics, EBSCO/ABI
Year: 2008
Key words: SB correlation, inflation economic growth
Study Background
Research Question (s): What is the impact of macroeconomic expectations on SB correlation?
Data Description: US, UK, Germany, daily data
Time Period: 1991 - 2006
Methodology
Model Employed: DCC, a simplified multivariate GARCH model
Empirical Contribution
Economy: Developed
Explanatory Variables: inflation, expected economic growth, perceived stock market uncertainty
SB Return Correlation: SB prices move in same direction during high inflation expectations, justifies “flight-to-safety” phenomenon.
Synthesis
Key contribution(s) to review question: SB relation changes substantially over short time period, inflation has more influence than rest.
Comments/observations/notes: model fit is poor

Ref. no. 2 (QAS: 222112)
Citation
Title: The determinants of stock and bond return comovements
Author(s): Baele, L., Bekaert, G., Inghelbrecht, K.
Journal / Source: Review of Financial Studies, EBSCO/ABI/Scopus
Year: 2009
Key words: Factor model, macroeconomic factors, SB correlation
Study Background
Research Question (s): What is the impact of macroeconomic expectations on SB correlation?
Data Description: US, daily data
Time Period: 1970 - 2008
Methodology
Model Employed: dynamic factor model
Empirical Contribution
Economy: Developed
Explanatory Variables: inflation, expected economic growth, cash flow growth, risk aversion, interest rates, liquidity proxies
SB Return Correlation: SB prices are influenced more by liquidity proxies than economic state variables.
Synthesis

Key contribution(s) to review question: SB relation changes substantially over short time period, inflation has more influence than rest.
Comments/observations/notes: model fit is poor, liquidity proxies need further analysis, variance premium makes the model fit for stock market volatility

Ref. no. 3 (QAS: 220112)
Citation
Title: Why don't the price of stocks and bonds move together?
Author(s): Barsky, R. B.
Journal / Source: American Economic Review, EBSCO/Scopus
Year: 1989
Key words: risk factor, productivity growth, SB price movements
Study Background
Research Question (s): What are the possible roles of risk and productivity growth on SB prices?
Data Description: Theoretical
Time Period: N/A
Methodology
Model Employed: general equilibrium asset pricing model
Empirical Contribution
Economy: N/A
Explanatory Variables: inflation, expected economic growth, cash flow growth, risk aversion, inter
SB Return Correlation: Stock prices rise with increased risk and decreased growth
Synthesis
Key contribution(s) to review question: Stock prices are influenced risk aversion factors
Comments/observations/notes: risk aversion factor contributes to asset volatilities in different ways

Ref. no. 4 (QAS: 212112)
Citation
Title: Inflation and the stock market: Understanding the "Fed Model"
Author(s): Bekaert, G., Engstrom, E.
Journal / Source: Journal of Monetary Economics, EBSCO/Scopus
Year: 2010
Key words: money illusion, equity premium, SB correlation, inflation, economic uncertainty
Study Background
Research Question (s): What is the impact of inflation on stock prices?
Data Description: US, daily
Time Period: 1965 - 2009
Methodology
Model Employed: VAR
Empirical Contribution
Economy: Developed
Explanatory Variables: inflation, expected economic growth, interest rate, money illusion
SB Return Correlation: SB yield responds to changes in inflation
Synthesis
Key contribution(s) to review question: money illusion has limited explanatory powers for high correlation between SB yields.
Comments/observations/notes: VAR produces robust results

Ref. no. 5 (QAS: 112112)
Citation
Title: Liquidity and expected returns: Lessons from Emerging Markets
Author(s): Bekaert, G., Harvey, C. R., Lundbald, C.
Journal / Source: Review of Financial Studies, EBSCO/ABI
Year: 2007
Key words: liquidity, expected returns, emerging markets
Study Background
Research Question (s): Does systematic variation in liquidity matters for stock returns?
Data Description: 19 emerging countries, monthly data
Time Period: 1993 - 2003
Methodology
Model Employed: asset pricing model
Empirical Contribution
Economy: Emerging economies
Explanatory Variables: liquidity
SB Return Correlation: zero daily firm returns significantly predicts stock returns; liquidity shocks are positively correlated to the stock return shocks
Synthesis
Key contribution(s) to review question: systematic liquidity risk is an important factor for measuring expected returns
Comments/observations/notes: VAR produces robust results

Ref. no. 6 (QAS: 212112)
Citation
Title: Risk, uncertainty and asset prices
Author(s): Bekaert, G., Engstrom, E., Zhang, X.
Journal / Source: Journal of Financial Economics, EBSCO/ABI
Year: 2009
Key words: equity premium, risk aversion, economic uncertainty, term structure, equity prices
Study Background
Research Question (s): Does systematic variation in liquidity matters for stock returns?
Data Description: US, quarterly data
Time Period: 1927 - 2004
Methodology
Model Employed: asset pricing model
Empirical Contribution
Economy: Developed
Explanatory Variables: risk aversion, inflation, consumption and dividend growth
SB Return Correlation: cash flow volatility drives the correlation
Synthesis
Key contribution(s) to review question: price-dividend ration and risk premium plays a important role in explaining equity returns; cash flow uncertainties and term structure is important to explain equity volatility
Comments/observations/notes: external habit model fits salient features of asset pricing behaviour, propositions are well stated

Ref. no. 7 (QAS: 222111)
Citation
Title: International Stock Return Comovements
Author(s): Bekaert, G., Hodrick, R. J., Zhang, X.
Journal / Source: Journal of Finance, EBSCO/ABI/Scopus
Year: 2009
Key words: international comovements, equity premium, risk aversion, economic uncertainty, term structure, equity prices
Study Background
Research Question (s): Does SB correlation varies according to country-specific factors?
Data Description: 23 developed, weekly data
Time Period: 1980 - 2005
Methodology
Model Employed: generalized linear models
Empirical Contribution
Economy: Developed
Explanatory Variables: three factor model variables
SB Return Correlation: European stock markets show evidence of increased correlation, industry related factors do not show persistent influence, large market value growth stocks are more correlated
Synthesis
Key contribution(s) to review question: SB correlation does not significantly depend of country-specific factors, Global integration is a major factor of this co-movement
Comments/observations/notes: dummy variable model fit is poor

Ref. no. 8 (QAS: 221112)
Citation
Title: Co-movement in international equity markets: A sectoral review
Author(s): Berben, R. P., Jansen, W. J.
Journal / Source: Journal of International Money and Finance, EBSCO/ABI/Scopus
Year: 2005
Key words: equity correlation, GARCH
Study Background
Research Question (s): Are the equity correlations different in different markets?
Data Description: Germany, Japan, UK, US, weekly data
Time Period: 1980 - 2000
Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Developed
Explanatory Variables: N/A
SB Return Correlation: equity correlation has doubled for countries except for Japan
Synthesis
Key contribution(s) to review question: equity correlation is not same across developed countries
Comments/observations/notes: a well represented application of STC GARCH model

Ref. no. 9 (QAS: 222122)
Citation

Title: Bond market and stock market integration in Europe: A smooth transaction Approach
Author(s): Berben, R. P., Jansen, W. J.
Journal / Source: Applied Economics, EBSCO/ABI/Scopus
Year: 2009
Key words: equity correlation, GARCH
Study Background
Research Question (s): What is the effect of market integration in Europe?
Data Description: European countries & US, weekly data
Time Period: 1980 - 2003
Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Developed
Explanatory Variables: N/A
SB Return Correlation: greater co-movements across the EMU markets
Synthesis
Key contribution(s) to review question: the correlation varies across markets; stock market integration process is more gradual than bond markets; bond market integration has been significantly influenced by EU
Comments/observations/notes: a well represented application of STC GARCH model

Ref. no. 10 (QAS: 210112)
Citation
Title: Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariances
Author(s): Bollerslev, T., Wooldridge, J. M.
Journal / Source: Econometric Review, EBSCO/Scopus
Year: 1992
Key words: QMLE, GARCH
Study Background
Research Question (s): What are the specific characteristics of dynamic model that define covariances?
Data Description: N/A
Time Period: N/A
Methodology
Model Employed: QMLE
Empirical Contribution
Economy: N/A
Explanatory Variables: N/A
SB Return Correlation: N/A
Synthesis
Key contribution(s) to review question: QMLE provides good and robust results for dynamic models that measure covariances.
Comments/observations/notes: recommended model for dynamic covariance estimation

Ref. no. 11 (QAS: 212112)
Citation
Title: A capital asset pricing model with time-varying covariances
Author(s): Bollerslev, T., Wooldridge, J. M.
Journal / Source: The Journal of Political Economy, EBSCO/ABI

Year: 1988
Key words: conditional variance, GARCH
Study Background
Research Question (s): What are the specific characteristics of dynamic model that define covariances?
Data Description: US, quarterly data
Time Period: 1959 - 1984
Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Developed
Explanatory Variables: N/A
SB Return Correlation: conditional variance is autoregressive; covariance matrix is time-varying; covariances are better represented by implied market volatility; information address the issues related to heteroskedastic return distribution;
Synthesis
Key contribution(s) to review question: conditional variances are significant in determining risk premium; the asset pricing implied beta are time varying; consumption changes influence return distribution
Comments/observations/notes: recommended model for dynamic covariance estimation

Ref. no. 12 (QAS: 212112)
Citation
Title: On the relationship between the conditional mean and volatility of stock returns: A latent VAR approach
Author(s): Brandt, M. W., Kang, Q.
Journal / Source: Journal of Financial Economics, EBSCO/ABI/Scopus
Year: 2004
Key words: conditional mean, volatility, stock returns, business cycles
Study Background
Research Question (s): What are the specific characteristics of intertemporal asset return relationships?
Data Description: US, monthly data
Time Period: 1946 - 1998
Methodology
Model Employed: VAR
Empirical Contribution
Economy: Developed
Explanatory Variables: N/A
SB Return Correlation: stock returns are negatively correlated to the two innovations in moment: mean-in-volatility and volatility-in-mean; intertemporal relationships generate variation in implied sharp ratio which is consistent with habit information intuition
Synthesis
Key contribution(s) to review question: intertemporal relationships shows patterns related to business cycle
Comments/observations/notes: additional innovation in moments provide better model specifications

Ref. no. 13 (QAS: 221112)
Citation
Title: On the volatility and co-movement of US financial markets around macroeconomic news announcements
Author(s): Brenner, M., Pasquariello, P., Subrahmanyam, M.
Journal / Source: Journal of Financial and Quantitative Analysis, EBSCO/ABI

Year: 2009
Key words: economic news, GARCH-DCC
Study Background
Research Question (s): What are links between US financial market and real economy?
Data Description: US, daily data
Time Period: 1982 - 2002
Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Developed
Explanatory Variables: macroeconomic information (CPI, unemployment rate, target federal funds, payroll employment)
SB Return Correlation: unexpected macroeconomic use has significant effect on the market; equity volatility decreases before the announcement and increases after the announcement; debt market effects are reversal; absolute magnitudes of the effects are asymmetric
Synthesis
Key contribution(s) to review question: markets react to information content
Comments/observations/notes: GARCH dynamic conditional correlation model is employed for fitting observed value

Ref. no. 14 (QAS: 212112)
Citation
Title: What moves the stock and bond markets? A variance decomposition for long-term asset returns
Author(s): Campbell, J. Y., Ammer, J.
Journal / Source: Journal of Finance, EBSCO/ABI/Scopus
Year: 1993
Key words: macroeconomic factors, low SB correlation
Study Background
Research Question (s): What moves SB returns?
Data Description: US, monthly data
Time Period: 1952 - 1987
Methodology
Model Employed: VAR
Empirical Contribution
Economy: Developed
Explanatory Variables: excess SB returns, future equity dividends, inflation and short-term real interest rate
SB Return Correlation: stocks are driven by expected dividend yield and bonds by inflation; real interest rate has no significant influence on returns
Synthesis
Key contribution(s) to review question: inflation is the major contributor; low SB correlation over post war US financial market
Comments/observations/notes: forecasting on monthly data may accumulate results and yield misleading conclusions

Ref. no. 15 (QAS: 222111)
Citation
Title: Characterising world market integration through time

Author(s): Carrieri, F., Errunza, V., Hogan, K.
Journal / Source: Journal of Financial and Quantitative Analysis, EBSCO/ABI
Year: 2007
Key words: market integration, emerging economies
Study Background
Research Question (s): What are the factors that explain variations in market integration?
Data Description: 8 emerging economies, monthly data
Time Period: 1977 - 2000
Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Emerging markets
Explanatory Variables: MSCI world index, MSCI global index portfolios, ADRs
SB Return Correlation: local risk explains time-variation in country market integration
Synthesis
Key contribution(s) to review question: local risk of countries affect financial integration; dynamics are not segmented; degree of financial integration varies; rules and regulations play a crucial role
Comments/observations/notes: use of I-CAPM beneficial in decomposing cross-country dynamics to test for integration hypothesis; correlation underestimates degree of integration

Ref. no. 16 (QAS: 211112)
Citation
Title: An empirical analysis of stock and bond market liquidity
Author(s): Chordia, T., Sarker, A., Subrahmanyam, A.
Journal / Source: Review of Financial Studies, EBSCO/ABI/Scopus
Year: 2005
Key words: cross-market liquidity, volatility shocks
Study Background
Research Question (s): What are common determinants of stock and bond market liquidity?
Data Description: US, tick-by-tick data
Time Period: 1991 - 1998
Methodology
Model Employed: VAR
Empirical Contribution
Economy: Developed
Explanatory Variables: liquidity factors
SB Return Correlation: Regularities in SB liquidity reflects each other, liquidity volatility explains return variance
Synthesis
Key contribution(s) to review question: local risk of countries affect financial integration; dynamics are not segmented; degree of financial integration varies; rules and regulations play a crucial role
Comments/observations/notes: inclusion and exclusion of parameters are well explained, links micro-structure liquidity to macro-level cash flows

Ref. no. 17 (QAS: 212112)
Citation
Title: A stochastic behaviour of common stock variances: Value, leverage and interest rate effects

Author(s): Christie, A. A.
Journal / Source: Journal of Financial Economics, EBSCO/ABI/Scopus
Year: 1982
Key words: stock variance
Study Background
Research Question (s): What is the relationship between stock price variance and rate of return?
Data Description: US, daily data
Time Period: 1962 – 1978
Methodology
Model Employed: MLE
Empirical Contribution
Economy: Developed
Explanatory Variables: financial leverage, interest rate
SB Return Correlation: equity variance is positively related to financial leverage and interest rate
Synthesis
Key contribution(s) to review question: macroeconomic factors and the issue of elasticity remains to be studied further
Comments/observations/notes: MLE is good to account for elasticity

Ref. no. 18 (QAS: 222221)
Citation
Title: Production based asset-pricing and the link between stock returns and economic fluctuations
Author(s): Cochrane, J. H.
Journal / Source: Journal of Finance, EBSCO/ABI
Year: 1991
Key words: stock variance, economic fluctuations
Study Background
Research Question (s): What is the relationship between stock price variance and economic fluctuations?
Data Description: US, daily data
Time Period: 1947 – 1987
Methodology
Model Employed: Production-based Asset Pricing Model
Empirical Contribution
Economy: Developed
Explanatory Variables: GNP, investments, capital ratios, dividend-price ratio
SB Return Correlation: equity returns and investment returns vary differently to capital ratios
Synthesis
Key contribution(s) to review question: dividend-price ratios better forecast stock returns
Comments/observations/notes: Production-based asset pricing adequately models economic factors to stock variance, calculations of the variables are clearly presented

Ref. no. 19 (QAS: 212112)
Citation
Title: Stock market uncertainty and stock-bond return relation
Author(s): Connolly, R., Stivers, C., Sun, L.
Journal / Source: Journal of Financial and Quantitative Analysis, EBSCO/ABI/Scopus
Year: 2005

Key words: stock variance, SB correlation
Study Background
Research Question (s): What is the relationship between SB returns and stock market uncertainty?
Data Description: US, daily data
Time Period: 1986 – 2000
Methodology
Model Employed: Generalized linear models
Empirical Contribution
Economy: Developed
Explanatory Variables: implied volatility, stock turnover
SB Return Correlation: SB correlation has a negative relationship with stock variance
Synthesis
Key contribution(s) to review question: stock variances have an impact on SB prices and return co-movements
Comments/observations/notes: the model fit for generalized linear models is no significant

Ref. no. 20 (QAS: 222112)
Citation
Title: Commonality in the time-variation of stock-stock and stock-bond co-movements
Author(s): Connolly, R., Stivers, C., Sun, L.
Journal / Source: Journal of Financial Markets, EBSCO/ABI/Scopus
Year: 2007
Key words: implied volatility, cross-country correlation
Study Background
Research Question (s): What is the impact of implied volatility on stock returns and SB returns?
Data Description: Europe & US, daily data
Time Period: 1992 – 2002
Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Developed
Explanatory Variables: implied volatility, stock turnover
SB Return Correlation: Cross-country stock covariance positively relates with high implied volatility; stock-stock return linkages are more influenced by implied volatility than SB return co-movements
Synthesis
Key contribution(s) to review question: implied volatility plays a part
Comments/observations/notes: the model fit for generalized linear models is no significant; regime switching model can be used for examining temporal commonality of covariance

Ref. no. 21 (QAS: 212112)
Citation
Title: International stock-bond correlation in a simple affine asset pricing model
Author(s): d'Addona, S., Kind, A. H.
Journal / Source: Journal of Banking & Finance, EBSCO/ABI
Year: 2006
Key words: economic fundamentals, SB correlation
Study Background
Research Question (s): What is the impact of economic fundamentals on SB correlation?

Data Description: G7, daily data
Time Period: 1973 – 2003
Methodology
Model Employed: Affine Asset Pricing Model
Empirical Contribution
Economy: Developed
Explanatory Variables: real interest rate, inflation, dividend yield
SB Return Correlation: volatility of real interest rate increases correlation; inflation shocks reduces correlation; dividend yield volatility reduces correlation
Synthesis
Key contribution(s) to review question: real interest rate, inflation and dividend yield plays an intuitive role in SB correlation
Comments/observations/notes: three factor asset pricing model is well implemented, test of correlation is done in an elaborate manner, derivation for endogenous correlation is appropriate

Ref. no. 22 (QAS: 222111)
Citation
Title: Time-varying market integration and expected returns in emerging markets
Author(s): De Jong, F., De Roon, F. A.
Journal / Source: Journal of Financial Economics, EBSCO/ABI/Scopus
Year: 2005
Key words: emerging markets, asset pricing
Study Background
Research Question (s): What is the impact of economic fundamentals on SB correlation?
Data Description: 30 emerging markets, monthly data
Time Period: 1988 – 2000
Methodology
Model Employed: Generalized linear models
Empirical Contribution
Economy: Emerging
Explanatory Variables: country risk, openness
SB Return Correlation: return volatility is a function of country risk and follows a direct relationship
Synthesis
Key contribution(s) to review question: expected returns are affected by country-specific and global level of segmentation; effect of segmentation and beta have equal signs;
Comments/observations/notes: generalized linear model fit is inadequate to measure cross-country dynamics

Ref. no. 23 (QAS: 222111)
Citation
Title: The relative informational efficiency of stock and bonds: An intraday analysis
Author(s): Downing, C., Underwood, S. And Xing, Y.
Journal / Source: Journal of Financial and Quantitative Analysis, EBSCO/ABI/Scopus
Year: 2009
Key words: intraday, economic variables
Study Background
Research Question (s): What is the evidence of informational efficiency on intraday SB returns?
Data Description: US, intraday analysis

Time Period: 2002 – 2005
Methodology
Model Employed: Generalized linear models
Empirical Contribution
Economy: Developed
Explanatory Variables: interest rates, news
SB Return Correlation: hourly stock returns lead convertible bonds returns; SR correlation reflects informational efficiency
Synthesis
Key contribution(s) to review question: interest rates affect bond returns and news affects stock returns
Comments/observations/notes: generalized linear model fit is inadequate to measure cross-country dynamics

Ref. no. 24 (QAS: 211112)
Citation
Title: How markets process information: News releases and volatility
Author(s): Ederington, L. H., Lee, J. H.
Journal / Source: Journal of Finance, EBSCO/ABI/Scopus
Year: 1993
Key words: macroeconomic news, interest rates, future markets
Study Background
Research Question (s): What is impact of macroeconomic news on interest rates and future markets?
Data Description: US, intraday analysis
Time Period: 1988 - 1991
Methodology
Model Employed: Generalized linear models
Empirical Contribution
Economy: Developed
Explanatory Variables: employment report, CPI, PPI
SB Return Correlation: prices respond quickly to news announcements; volatility has a more longer effect
Synthesis
Key contribution(s) to review question: news announcements influences volatility to a greater extent on an intra-day basis; exchange rate is influence by, CPI, PPI, employment news, retail sales, durable goods order, merchandise trade deficit; results may be same for spot exchange and interest rates.
Comments/observations/notes: Recommended intra-day analysis

Ref. no. 25 (QAS: 112111)
Citation
Title: Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models
Author(s): Engle, R.
Journal / Source: Journal of Business and Economic Statistics, EBSCO/Scopus
Year: 2002
Key words: correlation, GARCH
Study Background
Research Question (s): Does DCC predicts superior estimates?
Data Description: US, daily data
Time Period: 1990 - 2000

Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Developed
Explanatory Variables: N/A
SB Return Correlation: N/A
Synthesis
Key contribution(s) to review question: estimates are significant when the volatility is high
Comments/observations/notes: DCC yields significant estimates

Ref. no. 26 (QAS: 212111)
Citation
Title: Dynamic conditional correlation: Inflation regime and sources of inflation uncertainty
Author(s): Evans, M., Wachtel, P.
Journal / Source: Journal of Money, Credit and Banking, EBSCO
Year: 1993
Key words: inflation, regime switching
Study Background
Research Question (s): What is the behaviour of inflation in the post-war period?
Data Description: US, daily data
Time Period: 1950 - 1992
Methodology
Model Employed: Markov switching model (VAR)
Empirical Contribution
Economy: Developed
Explanatory Variables: N/A
SB Return Correlation: inflation changes significantly affects asset prices and returns, unemployment, biased ration forecast, government and institutional policies
Synthesis
Key contribution(s) to review question: regime changes affect real economic activity
Comments/observations/notes: switching model better captures structural changes in inflation behaviour

Ref. no. 27 (QAS: 222111)
Citation
Title: Shock effects on stocks, bonds and exchange rates
Author(s): Fair, R. C.
Journal / Source: International Money and Finance, EBSCO/Scopus
Year: 2003
Key words: exchange rates, tick data
Study Background
Research Question (s): What is the monetary and real event on stock returns and exchange rates?
Data Description: US, tick data
Time Period: 1982 - 2000
Methodology
Model Employed: Generalized linear models
Empirical Contribution
Economy: Developed

Explanatory Variables: CPI, PPI, BOT, retail sales, order of durable goods, housing starts, national income, GDP
SB Return Correlation: stock prices react negatively to negative monetary event whereas positive real events have a positive effect; exchange rates react negatively to positive monetary event and price event
Synthesis
Key contribution(s) to review question: tick data is used for event study of monetary, price and real
Comments/observations/notes: results can be generalized to other developed markets

Ref. no. 28 (QAS: 211112)
Citation
Title: Information and volatility linkages in the stock, bond and money markets
Author(s): Fleming, J., Kirby, C., Ostdiek, B.
Journal / Source: Journal of Financial Economics, EBSCO/ABI
Year: 1998
Key words: stochastic volatility, common information, market linkages
Study Background
Research Question (s): Is there evidence of volatility linkages across markets?
Data Description: US, daily data
Time Period: 1983 - 1995
Methodology
Model Employed: GMM
Empirical Contribution
Economy: Developed
Explanatory Variables: inflation news
SB Return Correlation: volatility linkages of the SB markets re strong; SB correlation is important to form speculative demands
Synthesis
Key contribution(s) to review question: inflation news affects investor expectations; traders adjust holdings in other markets that leads to information spill over effects;
Comments/observations/notes: GMM provides evidence of information spill-over effects

Ref. no. 29 (QAS: 222121)
Citation
Title: Expected stock returns and volatility
Author(s): French, K. R., Schwert, G. W., Stambaugh, R. F.
Journal / Source: Journal of Financial Economics, EBSCO/ABI/Scopus
Year: 1987
Key words: stock volatility, stock return
Study Background
Research Question (s): What is the relationship between stock returns and volatility?
Data Description: US, monthly data
Time Period: 1928 – 1984
Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Developed
Explanatory Variables: inflation news
SB Return Correlation: expected market premium and stock return volatility are co-integrated; unexpected stock

returns are negatively related to unexpected volatility changes
Synthesis
Key contribution(s) to review question: variables have fluctuates widely during the concerned time period
Comments/observations/notes: GARCH models can be vied to price risk premium

Ref. no. 30 (QAS: 221112)
Citation
Title: On the relationship between the expected value and the volatility of the nominal excess return on stocks
Author(s): Golsten, L. R., Jagannathan, R., Runkle, D. E.
Journal / Source: Journal of Finance, EBSCO/ABI/Scopus
Year: 1993
Key words: stock volatility, stock return, interest rate
Study Background
Research Question (s): What is the relationship between stock returns and volatility?
Data Description: US, monthly data
Time Period: 1951 – 1989
Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Developed
Explanatory Variables: seasonality
SB Return Correlation: conditional mean and variance is negatively related; magnitude of residuals is inversely related to variance
Synthesis
Key contribution(s) to review question: seasonal volatility patterns effects stock return volatility and conditional variance; monthly excess returns are not statistically significant
Comments/observations/notes: GARCH – M models can be vied to estimate seasonal pattern in volatility and interest rates to predict conditional variance

Ref. no. 31 (QAS: 112111)
Citation
Title: Economic implications of bull and bear regimes in UK stock and bond returns
Author(s): Guidolin, M., Timmermann, A.
Journal / Source: The Economic Journal, EBSCO/Scopus
Year: 2005
Key words: stock volatility, stock return, interest rate
Study Background
Research Question (s): What are the economic implications of bull and bear market?
Data Description: UK, monthly data
Time Period: 1976 – 2000
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: seasonality
SB Return Correlation: SB return witness regime shifts that affects optimal portfolio estimates
Synthesis

Key contribution(s) to review question: asset allocation decisions are informed by persistent bear and bull run phases; predictability based on dividend yield provides poor fit
Comments/observations/notes: Exemplar of portfolio optimization, which is dependent on SB correlation

Ref. no. 32 (QAS: 212112)
Citation
Title: Economic news, exchange rates and interest rates
Author(s): Hardouvelis, G. A.
Journal / Source: Journal of International Money and Finance, EBSCO/ABI
Year: 1988
Key words: information, interest rate, exchange rates
Study Background
Research Question (s): What is the effect of information release on interest rates and exchange rates?
Data Description: US, monthly data
Time Period: 1979 - 1984
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: 15 economic variables
SB Return Correlation: appreciation in dollar is accompanied by a nominal interest rate
Synthesis
Key contribution(s) to review question: Mundell-Fleming model holds good for analysing effects of macroeconomic factors
Comments/observations/notes: key study on macroeconomic variables that define business cycles

Ref. no. 33 (QAS: 112112)
Citation
Title: Do stock market liberalizations cause investment booms
Author(s): Henry, P. B.
Journal / Source: Journal of Financial Economics, EBSCO/ABI/Scopus
Year: 2000
Key words: liberalization, capital flows, emerging markets
Study Background
Research Question (s): What is the effect of liberalization on investment booms?
Data Description: 11 developing countries, monthly data
Time Period: 1977 - 1994
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Emerging markets
Explanatory Variables: GDP, debt-to-GDP, business cycle indicators
SB Return Correlation: stock market liberalization leads to investment boom; stock market valuation changes is correlated to investment growth rate
Synthesis
Key contribution(s) to review question: liberalizations plays a significant role in asset return dynamics
Comments/observations/notes: key study on market liberalization

Ref. no. 34 (QAS: 222111)
Citation
Title: Stock bond correlations
Author(s): Ilmanen, A.
Journal / Source: The Journal of Fixed Income, EBSCO/ABI/Scopus
Year: 2003
Key words: SB correlation, macro factors
Study Background
Research Question (s): What influences SB correlation?
Data Description: US, daily data
Time Period: 1987 - 2001
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: growth output, inflation, monetary, volatility
SB Return Correlation: Stronger growth positively relates to stocks but negatively to bonds; growth and volatility shocks decouples asset returns; monetary policy and inflation affects stock and bond returns in a similar manner; yield curve and inflation regimes are better able to distinguish SB co-movements
Synthesis
Key contribution(s) to review question: macro-factors determine SB co-movements
Comments/observations/notes: useful over of US SB co-movements

Ref. no. 35 (QAS: 122112)
Citation
Title: The relationship between bonds and stocks in emerging countries
Author(s): Kelly, J. M., Martins, L. F., Carlson, J. H.
Journal / Source: The Journal of Portfolio Management, EBSCO/ABI
Year: 1998
Key words: SB correlation, sovereign risk
Study Background
Research Question (s): What is the influences sovereign risk on SB correlation?
Data Description: Emerging countries, monthly data
Time Period: 1987 - 1995
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Emerging economies
Explanatory Variables: country's sovereign risk
SB Return Correlation: Stronger correlation than developed countries
Synthesis
Key contribution(s) to review question: sovereign risk contributes to volatility
Comments/observations/notes: the model fit is poor

Ref. no. 36 (QAS: 122112)
Citation
Title: Evolution of international stock and bond market integration: Influences of European Monetary Union
Author(s): Kim, S. J., Moshirian, F., Wu, E.
Journal / Source: Journal of Banking & Finance, EBSCO/ABI/Scopus
Year: 2006
Key words: SB correlation, market integration
Study Background
Research Question (s): What are the effects of EU on SB correlation?
Data Description: Emerging countries, monthly data
Time Period: 1994 - 2003
Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Developed
Explanatory Variables: interest rate, inflation, trade volume, monetary policy, term structure, dividend yield
SB Return Correlation: Real economic and currency reduction have positive effects on SB correlation; monetary policy have increased correlation volatility
Synthesis
Key contribution(s) to review question: integration affects correlation
Comments/observations/notes: GARCH model can be adopted for analysing financial integration

Ref. no. 37 (QAS: 112112)
Citation
Title: Modelling asymmetric comovements of asset returns
Author(s): Krogner, K., Ng, V. K.
Journal / Source: Review of Financial Studies, EBSCO/ABI/Scopus
Year: 1998
Key words: GARCH, covariance, best estimate
Study Background
Research Question (s): Which multivariate model yield better covariance estimate?
Data Description: US, weekly data
Time Period: 1992 - 1998
Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Developed
Explanatory Variables: past shock
SB Return Correlation: Existing model use strong restrictions on historical shocks
Synthesis
Key contribution(s) to review question: need to develop conditional variance models
Comments/observations/notes: Key paper for model comparison

Ref. no. 38 (QAS: 212112)
Citation
Title: How do policy and information shocks impact co-movements of China's T-bond and stock markets?
Author(s): Li, X. M., Zou, L. P.

Journal / Source: Journal of Banking & Finance, EBSCO/ABI
Year: 2008
Key words: dynamic correlation, macroeconomic factors
Study Background
Research Question (s): What is the effect of policy and information release on Chinese financial assets?
Data Description: China, weekly data
Time Period: 2003 - 2005
Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Emerging
Explanatory Variables: information
SB Return Correlation: Reacts largely to shocks, correlation reacts for strongly to negative than positive shocks
Synthesis
Key contribution(s) to review question: information release plays a crucial role
Comments/observations/notes: sample for emerging economy

Ref. no. 39 (QAS: 122112)
Citation
Title: Time-varying market integration and stock and bond return concordance in emerging markets
Author(s): Panchenko, V., Wu, E.
Journal / Source: Journal of Banking & Finance, EBSCO/ABI/Scopus
Year: 2009
Key words: liberalization, correlation
Study Background
Research Question (s): What is the effect of stock market integration on SB correlation?
Data Description: 18 emerging markets, weekly data
Time Period: 1995 - 2005
Methodology
Model Employed: non-parametric
Empirical Contribution
Economy: Emerging
Explanatory Variables: inflation, stock marketed turnover ratio, GDP, US interest rate
SB Return Correlation: financial flows affect SB correlation, bond variation becomes more discordant as the market opens up more
Synthesis
Key contribution(s) to review question: financial integration plays a role linked to developed economies
Comments/observations/notes: sample data for emerging economy

Ref. no. 40 (QAS: 211111)
Citation
Title: Why does stock market volatility change over time?
Author(s): Schwert, G. W.
Journal / Source: Journal of Finance, EBSCO/ABI/Scopus
Year: 1990
Key words: economic factors, stock volatility
Study Background

Research Question (s): What is the effect of macroeconomic factors on SB co-movement?
Data Description: US, monthly data
Time Period: 1857 - 1987
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: economic volatility, economic activity, financial leverage, equity trading volume
SB Return Correlation: volatility is much higher during recession; effects of financial leverage is small; estimates of macroeconomic coefficients are positive
Synthesis
Key contribution(s) to review question: macroeconomic volatility does to significantly predict SB volatility; rest of the factors have a positive relationship.
Comments/observations/notes: to be referred for a general overview

Ref. no. 41 (QAS: 222111)
Citation
Title: Risk premia and the dynamic correlation between stock and bond returns?
Author(s): Scruggs, J. T., Glabadanidis, P.
Journal / Source: Journal of Banking & Finance, EBSCO/ABI
Year: 2003
Key words: Stock bond risk premia, covariance
Study Background
Research Question (s): Does inter-temporal risk premia explain time varying covariances?
Data Description: US, monthly data
Time Period: 1853 - 1997
Methodology
Model Employed: Asymmetric dynamic covariance model
Empirical Contribution
Economy: Developed
Explanatory Variables: economic volatility, economic activity, financial leverage, equity trading volume
SB Return Correlation: conditional stock variance responds asymmetrically to both SB returns shocks whereas bond variance only responds to bond return shocks
Synthesis
Key contribution(s) to review question: constant correlation is strongly rejected
Comments/observations/notes: two-factor model fit is not significant

Ref. no. 42 (QAS: 222111)
Citation
Title: Stock price and bond yields: Can their co-movements be explained in terms of present value models?
Author(s): Shiller, R. J., Beltratti, A. E.
Journal / Source: Journal of Monetary Economics, EBSCO/ABI
Year: 1992
Key words: co-variation, interest rate, inflation rate
Study Background
Research Question (s): Does present value models explain SB co-variations?
Data Description: US & UK, monthly data

Time Period: 1918 – 1989
Methodology
Model Employed: Generalized linear models
Empirical Contribution
Economy: Developed
Explanatory Variables: interest rate, inflation
SB Return Correlation: interest rate and stock prices are inversely correlated; stock prices have little correlation with inflation rate
Synthesis
Key contribution(s) to review question: correlation is dynamic and the results are contradictory
Comments/observations/notes: model fit is poor

Ref. no. 43 (QAS: 211112)
Citation
Title: Inflation illusion and stock prices
Author(s): Vuolteenaho, T., Campbell, J.
Journal / Source: American Economic Review, EBSCO/ABI
Year: 2004
Key words: macro economy, stock returns
Study Background
Research Question (s): What is the effect of inflation on stock prices?
Data Description: US, monthly data
Time Period: 1918 – 1989
Methodology
Model Employed: Generalized linear models
Empirical Contribution
Economy: Developed
Explanatory Variables: inflation
SB Return Correlation: stabilization of inflation reduces volatility
Synthesis
Key contribution(s) to review question: inflation significantly affects stock volatility
Comments/observations/notes: Modigliani-Cohn hypothesis test is well illustrated

Ref. no. 44 (QAS: 222111)
Citation
Title: Stock bond correlation and its implication for asset allocation
Author(s): Wainscott, C. B.
Journal / Source: Financial Analysts Journal, EBSCO/ABI/Scopus
Year: 1990
Key words: asset allocation, stock bond correlation
Study Background
Research Question (s): Is asset correlation significantly predicted from historical data?
Data Description: US, monthly data
Time Period: 1918 – 1989
Methodology
Model Employed: Generalized linear models
Empirical Contribution

Economy: Developed
Explanatory Variables: N/A
SB Return Correlation: correlation is time-varying
Synthesis
Key contribution(s) to review question: historical prediction is wrong
Comments/observations/notes: historical correlation used for prediction leads to false estimation

Ref. no. 45 (QAS: 212112)
Citation
Title: Stock bond correlation and macroeconomic conditions: One and a half centuries of evidence
Author(s): Yang, J., Zhou, Y., Wang, Z.
Journal / Source: Journal of Banking and Finance, EBSCO/ABI/Scopus
Year: 2009
Key words: stock bond correlation, business cycle
Study Background
Research Question (s): Is asset correlation significantly predicted from historical data?
Data Description: US & UK, monthly data
Time Period: 1855 – 2008
Methodology
Model Employed: GARCH
Empirical Contribution
Economy: Developed
Explanatory Variables: business cycle, inflation, monetary policy
SB Return Correlation: US market better responds to macro changes than UK; SB correlation follows higher short-interest rates and inflation rates
Synthesis
Key contribution(s) to review question: inflation and short-term interest rates influence correlation but they follow regime patterns/changes
Comments/observations/notes: generic over view for US & UK

Ref. no. 46 (QAS: 212221)
Citation
Title: The effects of inflation and money supply announcements on interest rates
Author(s): Urich, T., Wachtel, P.
Journal / Source: Journal of Finance, EBSCO/ABI
Year: 1984
Key words: inflation, money supply, interest rate
Study Background
Research Question (s): What is the impact of inflation and money supply announcement on interest rate?
Data Description: US, monthly data
Time Period: 1977 - 1982
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: CPI, PPI, money supply expectations
SB Return Correlation: N/A

Synthesis
Key contribution(s) to review question: PPI and money supply have an immediate positive short-term effect on interest rate; CPI has no apparent effect; evidence of liquidity effect of money supply change on interest rates
Comments/observations/notes: money supply expectation proxy and inflation proxy well defined
Ref. no. 47 (QAS: 222111)
Citation
Title: The impact of new economic information on the volatility of short-term interest rates
Author(s): Roley, V. V., Troll, R.
Journal / Source: Economic Review, EBSCO/ABI/Scopus
Year: 1983
Key words: inflation, money supply, interest rate, economic activity
Study Background
Research Question (s): What is the impact of announcement changes in economic activity, inflation and money supply on interest rate?
Data Description: US, weekly data
Time Period: 1977 - 1982
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: CPI, PPI, MI (money supply expectations), unemployment rate
SB Return Correlation: N/A
Synthesis
Key contribution(s) to review question: PPI and money supply have an immediate positive short-term effect on interest rate; CPI has no apparent effect; weekly release of money supply announcement have influence on the volatility of interest rates
Comments/observations/notes: economic activity, money supply expectation proxy and inflation proxy well defined

Ref. no. 48 (QAS: 211111)
Citation
Title: New evidence on optimal asset allocation
Author(s): Jensen, G. R., Mercer, J. M.
Journal / Source: Financial Review, EBSCO/ABI/Scopus
Year: 2003
Key words: asset allocation, co-variance
Study Background
Research Question (s): What is the effect of monetary cycle on co-variance structure in asset allocation efficiency?
Data Description: US, monthly data
Time Period: 1972 - 1999
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: monetary cycle and business cycle turning points
SB Return Correlation: co-variance structure is significantly influenced by changes in the monetary cycle
Synthesis

Key contribution(s) to review question: monetary cycle has greater impact than business cycle on asset allocation efficiency
Comments/observations/notes: economic activity, monetary cycle proxies have ex-ante information, monetary and business cycle turning points and dummy variables are well explained

Ref. no. 49 (QAS: 220111)
Citation
Title: Bond price volatility and term to maturity: A generalized re-specification
Author(s): Hopewell, M. H., Kaufman, G. G.
Journal / Source: The American Economic Review, EBSCO/ABI/Scopus
Year: 1973
Key words: asset allocation, co-variance
Study Background
Research Question (s): What is the effect of duration on bond prices?
Data Description: Theoretical
Time Period: N/A
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: yield to maturity, price, time to maturity
SB Return Correlation: bond volatility can be better measured using duration as it follows a positive relationship
Synthesis
Key contribution(s) to review question: duration plays a vital role in measuring default risk premium
Comments/observations/notes: defines duration

Ref. no. 50 (QAS: 211111)
Citation
Title: Decoupling
Author(s): Gulko, L.
Journal / Source: The Journal of Portfolio Management, EBSCO/ABI
Year: 2002
Key words: asset allocation, co-variance
Study Background
Research Question (s): What is the evidence of SB correlation decoupling before and after market crash?
Data Description: US, daily data
Time Period: 1945 - 2000
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: N/A
SB Return Correlation: strong evidence of SB correlation decoupling during crash period
Synthesis
Key contribution(s) to review question: has effect on portfolio construction, which emphasizes portfolio diversification
Comments/observations/notes: only paper that studies decoupling around crash period

Ref. no. 51 (cross-referencing) (QAS: 212112)
Citation
Title: What's vol. got to do with it
Author(s): Drechsler, L., Yaron, A.
Journal / Source: Review of Financial Studies, EBSCO/ABI/Scopus
Year: 2011
Key words: variance premium, volatility
Study Background
Research Question (s): What is the effect of variance premium on uncertainty?
Data Description: US, tick data
Time Period: 1990 - 2003
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: variance premium, risk aversion
SB Return Correlation: strong evidence of SB correlation with risk aversion than with economic uncertainty
Synthesis
Key contribution(s) to review question: variance premium is useful in estimating uncertainty
Comments/observations/notes: proxy for variance premium is well defined

Ref. no. 52 (cross-referencing) (QAS: 211112)
Citation
Title: Inflation, uncertainty, asset valuations and the credit spreads puzzle
Author(s): David, A.
Journal / Source: Review of Financial Studies, EBSCO/ABI/Scopus
Year: 2008
Key words: macroeconomic shocks, credit spreads, asset pricing
Study Background
Research Question (s): What is the evidence of credit spreads puzzle?
Data Description: US, weekly data
Time Period: 1960 - 2000
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: solvency ratios
SB Return Correlation: N/A
Synthesis
Key contribution(s) to review question: credit spreads fluctuate with macroeconomic shocks; credit spreads are convex in the solvency ratio
Comments/observations/notes: credit spreads puzzle explicitly stated

Ref. no. 53 (cross-referencing) (QAS: 222112)
Citation

Title: Global growth opportunities and market integration
Author(s): Bekaert, G., Harvey, C. R., Lundbald, C., Siegel, S.
Journal / Source: Journal of Finance, EBSCO/ABI/Scopus
Year: 2007
Key words: countries growth opportunities, market integration
Study Background
Research Question (s): What is the effect of market integration on growth opportunities?
Data Description: 50 countries, monthly data
Time Period: 1980 - 2002
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed & Emerging
Explanatory Variables: country's local industry index, global price earnings
SB Return Correlation: N/A
Synthesis
Key contribution(s) to review question: exogenous growth opportunities are maximum for liberalized countries; external finance, investors protection are less important factors
Comments/observations/notes: analysis of exogenous growth factors are well documented, country variables well stated

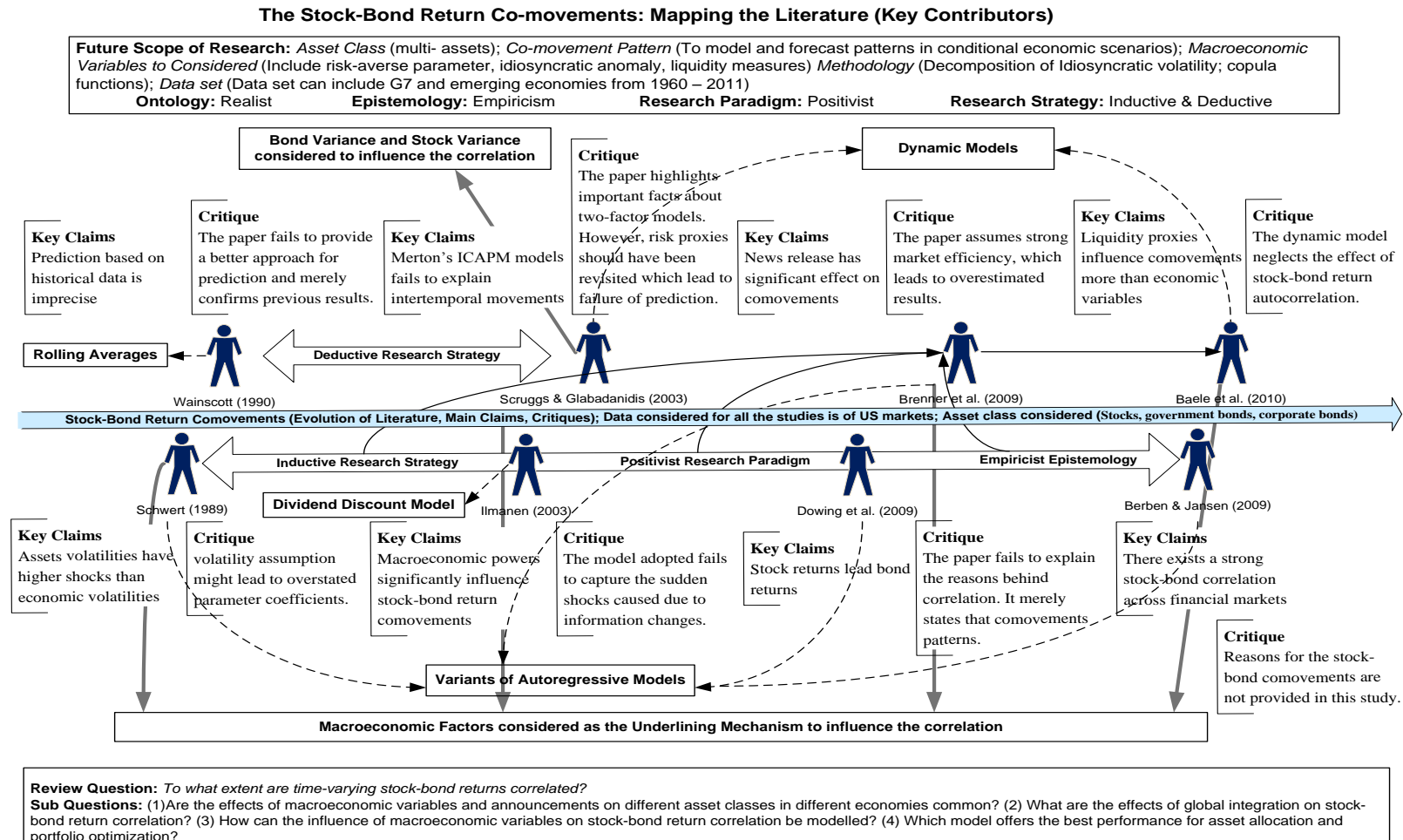
Ref. no. 54 (cross-referencing) (QAS: 112112)
Citation
Title: Expected stock returns and variance risk premia
Author(s): Bollerslev, T., Tauchen, G., Zhou, H.
Journal / Source: Review of Financial Studies, EBSCO/ABI
Year: 2009
Key words: variance premium. Stock volatility
Study Background
Research Question (s): What is the effect of variance premium on expected stock returns?
Data Description: US, intraday data
Time Period: 1980 - 2008
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: variance premium
SB Return Correlation: N/A
Synthesis
Key contribution(s) to review question: magnitude of predictability of return estimate by variance premium is strong for intermediate quarterly return
Comments/observations/notes: variance premium usefulness and definition is well stated

Ref. no. 55 (cross-referencing) (QAS: 220111)
Citation
Title: Consumption, production, inflation and interest rates: A synthesis
Author(s): Breden, D. T.

Journal / Source: Journal of Financial Economics, EBSCO/ABI
Year: 1986
Key words: interest rates, consumption, production, business cycle
Study Background
Research Question (s): What is the relationship between real and nominal interest rate and expected growth of real consumption and aggregate production?
Data Description: Theoretical
Time Period: N/A
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: interest rates, consumption, production
SB Return Correlation: N/A
Synthesis
Key contribution(s) to review question: riskless rates are positively related to expected growth of consumption with CARA coefficient; variance rate of consumption is negatively related; riskless rates are related to autocorrelation of production rates
Comments/observations/notes: constant absolute risk aversion assumption is properly defined

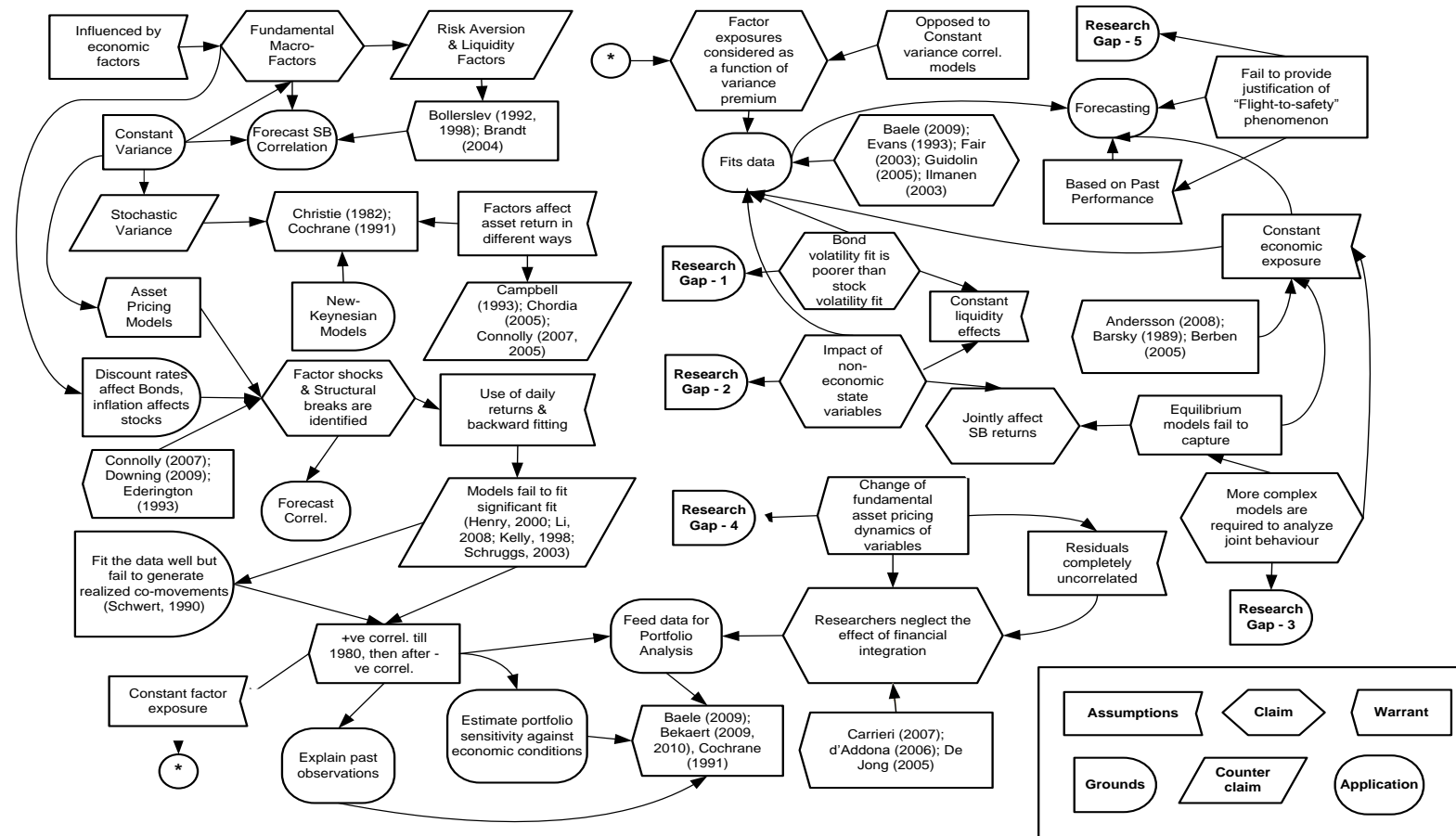
Ref. no. 56 (cross-referencing) (QAS: 212111)
Citation
Title: Real-time price discovery in global stock, bond and foreign exchange markets
Author(s): Andersen, T. G., Bollerslev, T., Diebold, F. X., Wu, G.
Journal / Source: Journal of International Economics, EBSCO/ABI
Year: 2007
Key words: macroeconomic news, stock and bond volatility, exchange rate
Study Background
Research Question (s): What is the effect of macroeconomic news on conditional dynamics of SB returns?
Data Description: US, Germany and UK, tick data
Time Period: 1998 - 2002
Methodology
Model Employed: Generalized linear model
Empirical Contribution
Economy: Developed
Explanatory Variables: interest rates, consumption, production
SB Return Correlation: News has impact on the dynamics; equity markets react differently based on business cycle
Synthesis
Key contribution(s) to review question: macroeconomic news has a strong effect and evidence on thigh frequency data
Comments/observations/notes: application of news on high frequency data is well illustrated

Appendix B: Literature Mapping



Appendix C: Argument Mapping

The SB Return co-movement: An Argument Map



Appendix D: Conditional Moment Tests

To carry out a robust conditional moment test on MGARCH models, the ex-post residual vector can be compared to the estimated co-variance matrix. In particular the Euclidian distance between the unconditional asset returns, i.e. e_{it}, e_{jt} , and the covariance, i.e. v_{ijt} , is measured to test the validity of the model. Further, analysis of observed pattern and be performed to comment the robustness of the models. For example, a low covariance estimate of a model dependent on information set at time ' $t-1$ ', suggests that the distance between e_{it}, e_{jt} and v_{ijt} is likely to take a positive value. Drawing on this, if a residual which measures the distance between the unexpected asset returns due to news impact v_{ijt} and the point e_{it}, e_{jt} , i.e. $\mu_{ijt} = e_{it}e_{jt} - v_{ijt}$, is zero then the model is validates as correct. Further is residual should be independent of any information set at time ' $t-1$ '. This also gives a way to identify misspecifications (Kroner and Ng, 1998). Thus, μ_{ijt} acts as a misspecification indicator.

To address the asymmetric properties, which cause differences in the estimation MGARCH results, the Euclidian e_{it-1}, e_{jt-1} space is partitioned in four quadrants. The misspecification indicators are assigned to each of these partitions.

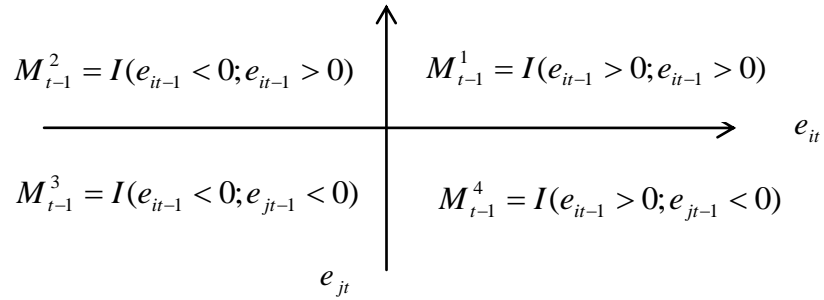


Figure: Misspecification Factors of Corresponding

In the above figure $I(.)$ is the function that refers to the corresponding argument of the specific quadrants. Engle and Ng (1990) claim that the magnitude of the shocks play a significant role. Hence, in order to capture this effect additional sign indicators are specified as $M^k_{t-1} = e_{i/j,t-1}^2 I(e_{i/j,t-1} < 0)$, where k takes the values from one to four,

representing the four quadrants. The robust test statistics is based on Wooldridge's (1990) GARCH model. It is compiles two auxiliary regressions as stated below.

$$RTS_{cm} = \left[\left(\frac{1}{T} \right) \sum_{t=1, T} \mu_{ijt} \Delta_{kt} - 1 \right]^2 \left[\left(\frac{1}{T} \right) \sum_{t=1, T} \mu_{ijt}^2 \Delta_{kt-1}^2 - 1 \right]^{-1}$$

where Δ_{kt} is the residual of regression of misspecification indicators on v_{ijt} . The robust test statistic confirms to $RTS_{cm} \sim \chi^2(1)$, asymptotic distribution (Wooldridge, 1990).

To demonstrate the usefulness of this validity test approach, I illustrate on the findings of Kroner and Ng (1998) on two portfolios concerning small and big-firm stocks (cf. Section 5.5, p. 42). The Ljung-Box (LB) test of auto-correlation ($e_{it}e_{jt}/v_{ijt}$) reported below shows that all the MGARCH models adequately capture the second moment serial correlation effects. This is, however, not surprising as LB tests rarely reject any of the variations of GARCH model in the extant literature.

Table: LB test of Serial Correlation ^a

	VECH	CCORR	FARCH	BEKK	ADC
$Q(6)$	3.81	6.18	1.18	2.50	5.63
$Q(12)$	6.42	10.39	4.28	5.58	7.90
$Q(18)$	9.39	13.37	9.07	9.88	10.43

^a Q(k) is the LB test statistic of the kth order auto-correlation. The critical values Q (6), Q (12) and Q (18) are 12.6, 21.0 and 36.4 at 95 percent confidence interval.

Source: Kroner and Ng (1998)

But, the conditional robust test results convey a different picture. The test statistics reported below significantly reject each model. The results show that all the models fail to capture the asymmetric variance effect of the past shocks. Further, it is evident that the model performance deteriorates if the shocks are larger. This suggests that the magnitude of the shocks play a critical role in estimating asset return covariance matrix. The rejections are pronounced when the misspecification indicators are negative for both the portfolios. This has two implications. First, this might be an effect of the high return correlation between the two portfolios. Second, this might arise from high asymmetric common shocks of both the small and the large-firm portfolios. An intuitive response will be to argue that a big shock will be shared by both the portfolios. Hence, the misspecification indicators will lie in either (+,+) or (-,-) quadrants.

Table: Diagnostic Tests of Model specification ^a

	VECH	CCORR	FARCH	BEKK	ADC
$I(\varepsilon_{1t-1} < 0)$	4.85	5.32	4.91	4.85	—
$I(\varepsilon_{2t-1} < 0)$	16.22	17.63	16.34	16.27	5.48
$I(\varepsilon_{1t-1} < 0; \varepsilon_{2t-1} < 0)$	5.88	10.95	6.40	6.45	—
$I(\varepsilon_{1t-1} < 0; \varepsilon_{2t-1} > 0)$	—	6.84	—	—	—
$I(\varepsilon_{1t-1} > 0; \varepsilon_{2t-1} < 0)$	—	—	—	4.10	—
$I(\varepsilon_{1t-1} > 0; \varepsilon_{2t-1} > 0)$	11.09	10.46	12.06	12.67	—
$\varepsilon_{1t-1}^2 I(\varepsilon_{1t-1} < 0)$	—	—	—	—	—
$\varepsilon_{1t-1}^2 I(\varepsilon_{2t-1} < 0)$	3.99	6.45	5.01	5.54	—
$\varepsilon_{2t-1}^2 I(\varepsilon_{1t-1} < 0)$	—	4.03	4.24	5.40	—
$\varepsilon_{2t-1}^2 I(\varepsilon_{2t-1} < 0)$	4.41	4.95	5.11	6.29	—

^a The table reports the test static values of the misspecification indicators of the four MGARCH models. At 95 percent confidence level the critical value of the test statistic is 3.48. The table only reports the significant values. The subscript (1) refers to small-firm stocks and subscript (2) refers to large-firm stocks.

Source: Kroner and NG (1998)

An important insight from this illustration is that the LB tests are insufficient to account for the statistical verification of good-fit models. Even falsely specified models can pass the LB test of serial correlation to claim that they capture the auto-correlation of higher moments.

Glossary

Arbitrage Pricing Theory	A theory that states expected return of a financial asset is a function of various risk factors.
Asset Allocation	The process of distribution an investor's wealth among various asset classes for portfolio construction.
Asset Class	Securities that are grouped together based on similar risk and return relations and attributes.
Beta	An estimate of systematic risk as a function of asset's sensitivity to market portfolio.
Bonds	Securities with fixed income payments.
Brownian Motions	A stochastic process where the change in the underlying variable at an infinitesimally small period follows a normal distribution with mean and variance proportional to the length of that period.
Capital Asset Pricing Model (CAPM)	A theory that derives expected return of an asset based on systematic risk and risk-free rate of return.
Copula	A techniques to measure correlation between variables with identifiable distributions
Correlation Coefficient	A statistic that measures the relationship between two variables. It varies from (-) one to (+) one.
Diversification	A process of minimizing unsystematic risks in a portfolio.
Economic Index	A statistical measure of changes of an economic state variable.
Efficient Frontier	The loci of portfolios that have the maximum payoffs for a particular level of risk.
Flight to Quality	Relates to the situation when investors move their investments from more risky to less risky assets.
GARCH Model	A technique employed to forecasts volatility. In these type of models the variances follow a mean-reverting process.
Hedging	An investment process or a trading strategy undertaken to eliminate a particular source of risk.

Idiosyncratic Volatility	The volatility caused due to unique characteristics of a specific financial instrument.
Investment	A commitment of fund by an investor for a specific period of time in order to derive expected returns that compensate investor's opportunity cost for that period.
Marginal Risks	Rate of change of risk with respect to a small variation in a particular variable.
Markov Chain	A stochastic process where the next change of an event depends on the present state and not on the preceding sequence of events.
Maximum Likelihood Function	A technique that estimates the parameters of a model by maximizing the probability of occurrence of an observed variable.
Mutual Fund Theorem	A theorem stating that investor's portfolio should hold a combination of risky and risk free assets depending on the risk preference of the investor.
Optimal Portfolio	The investor specific highest utility portfolio on the efficient frontier.
Portfolio Management	Managing a group of investments that have different payoff patterns over time.
Portfolio Optimization	A technique that maximizes portfolio returns subjected to equation of constraints. These are ideally based on risk and applicability of short selling.
Portfolio Return	The expected return of a group of investments over a specific period of time.
Principal Component Analysis	An analysis to determine the factors that explain most of the variations in a group of correlated variables.
Quadratic Programming	It relates to optimization of a quadratic function subjected to equation of constraints.
Regime-switching Model	A time-series model where parameters take a specific value for some defined regimes.
Regression Analysis	A technique used to determine the relationship of a dependent variable as a function of a number of independent variables.

Return	The expected payoff an investor estimates by holding an investment for a specific period of time.
Risk	The volatility of future returns that is influenced by various economic factors, market factors and firm performance.
Risk Premium	The compensation an investor seeks because of investment uncertainty.
Stochastic Process	A model defining the probabilistic behavior of a variable, which has an uncertain future outcome.
Separation Theorem	The former employs investment in the market portfolio and the later is based on specific investor's risk preference.
Stationary Process	A stochastic process where the statistical properties of a variable are time-independent.
Stocks	Generally refers to common stocks that are equity investment stating ownership of a firm.
Tail Dependency	It relates to the degree of correlation in the tail of two variables in the same probability space.
Utility Function	A locus that represents preference of economic entities based on risk and expected return of an investment.
Variance	A statistic to measure variability across the mean. It is equal to sum of the squared differences from the mean divided by the total number of observations.